Implementation of Problem Based Learning (PBL) - in a Malaysian Teacher Education Course

Issues and Benefits From Students Perspective

Borhan, Mohamad Termizi Bin; Yassin, Sopia Md

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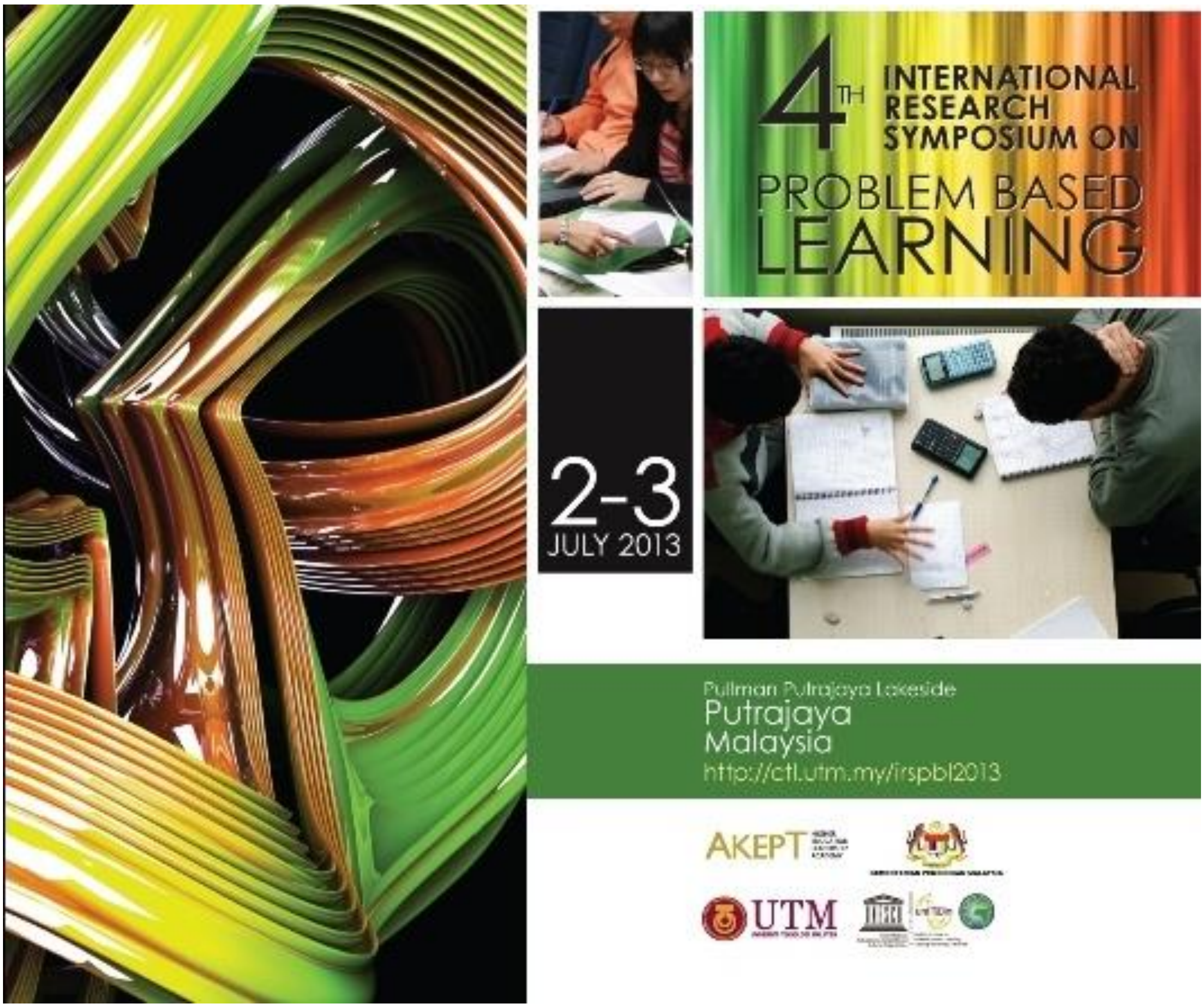
Khairiyah Mohd-Yusof, Mahyuddin Arsat,
Mohamad Termizi Borhan,Erik de Graaff,
Anette Kolmos, Fatin Aliah Phang (Eds.)



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PBL Across Cultures

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Khairiyah Mohd-Yusof, Erik de Graaff and Anette Kolmos, Mahyuddin Arsat, Mohamad Termizi Borhan, Fatin Aliah Phang

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Introduction

Over the past decades Problem Based and Project Based Learning (PBL) has proved to be a highly successful method for training professionals in higher education. After first spreading in Canada, USA, Europe and Australia more recently also many institutes in Asia, Africa and South America have been introducing this educational method. As a consequence, the cultural dimension in PBL has gained in importance. For instance, the group work is one of the hallmarks of PBL. Western countries like Denmark and Holland score moderately low on the culture dimensions Power Distance and Uncertainty Avoidance. Consequently it is common for students to discuss among themselves topics and share their knowledge in collaborating on a problem, or even to argue with a teacher. In other cultures with a higher Power Distance or a more masculine competitive nature such behaviour is much less natural or may even be unacceptable. Evidently, the PBL group process will develop differently in different cultural environments. However, little is known about the specific influence of cultural aspects on the PBL process.

This cultural dimension is the topic has been chosen as the central theme of the fourth international PBL research symposium in Kuala Lumpur, Malaysia. The first of these symposia was held at Aalborg University in June 2008 a year after the establishment of the UNESCO Chair in Problem Based Learning, aiming to initiate a worldwide community of researchers on PBL. UCPBL collaborated with host organizations in different countries around the world to continue this initiative supporting the research community. The second research symposium was held in Melbourne, hosted by Victoria University in December 2009. At the time Victoria University was going through a process of organisational change introducing PBL in her curricula. The third International Research Symposium on Problem-Based Learning hosted by Coventry University, 28-29 November 2011 focused on collecting best practices across the disciplines. Coventry University was also in the middle of a change process towards more PBL in her curricula.

In Asia several institutes have implanted PBL during the past decades. Universiti Teknologi Malaysia (UTM) in Kuala Lumpur, one of the outstanding centres of educational innovation and research hosts the 4th International Research Symposium on PBL, July 2-3 2013. Once more the symposium aims to bring together researchers studying all aspects of the learning process in problem based and project based learning, and those involved in the implementation of these approaches across the disciplines from all over the world. Under the umbrella of the over all theme PBL ACROSS CULTURES, the symposium asked for contributions on the following sub-themes:

- Approaches to PBL
- The learning process (cognitive studies)
- Evaluating practice – models and approaches
- Theorising practice
- Management of change
- Learning spaces
- Teacher roles in PBL
- Learning technologies for PBL
- Student engagement with PBL

- Virtual PBL
- Cross disciplinary PBL
- Gender and diversity
- Generating innovative and interdisciplinary knowledge and practices
- PBL for continuing professional development
- Curriculum design
- Assessment methods
- Case studies

Sharing (new) knowledge is the key aspect of every research symposium. Normally that is achieved through a series of individual lecture like presentations. However, at a symposium on PBL the participants may expect to be more actively involved. In order to the necessary create variation the papers have been assigned to three different presentation formats. Besides the traditional short paper presentation format there is a panel presentation and a PBL presentation format. In all cases an essential part of the information will be made available in this book of proceedings. Participants at the conference are expected to prepare for the sessions by reading the contributions beforehand. Therefore, the order of presenting the papers in this book follows as close as possible the structure of the symposium programme.

We wish you all a good time preparing for the IRSPBL in Malaysia.

And remember: ‘Knowledge is something that grows in the process of sharing’

Khairiyah Mohd-Yusof, Mahyuddin bin Arsat, Mohamad Borhan, Erik de Graaff, Annete Kolmos & Fatin Aliah Phang

Kuala Lumpur, Aalborg, June 2013

Globalization of Problem-Driven Learning: Design of a System for Transfer Across Cultures

Kinda Khalaf [a] *, Wendy Newstetter [b], Habiba Alsafar [a]

[d]*Department of Biomedical Engineering, Khalifa University, Abu Dhabi, UAE*
[b]*Department of Biomedical* Engineering, Georgia Institute of Technology Atlanta, USA

Abstract

In this paper, we report on an experiment in transnational exchange and cooperation between Georgia Tech in Atlanta, Georgia USA and Khalifa University in Abu Dhabi around the design of an introductory course in biomedical engineering delivered using problem-driven learning (PDL). Although the core of the PDL problems and scaffolding approach were adopted from GT, as well as the general course structure, the open-ended, ill-structured problems were specifically designed to "custom–fit" the KU and the UAE culture. In the process, the authors explored the design of an exportable system for PDL transfer across cultures. The main hypothesis lies in the successful globalization of PDL, through the design of a system for cross-cultural transfer based on the development of generic core problems with cultural-specific skins that address interdisciplinary skills unique to BME.

Keywords: Problem-Driven-Learning, engineering education , cross cultural transfer, 21st century skills;

1. Introduction

Engineering education stakeholders, from academic institutions, professors, and alumni to private sector industries, governmental education agencies and accreditation bodies universally agree that current engineering graduates lack the critical skills essential for the 21st century interconnected dynamic world that is rapidly being transformed by information explosion and monumental scientific and technological advances. Today's practicing engineer operates under multifaceted global, cultural, and business constraints, and hence needs a set of tools, skills and competencies to cope and compete within the boundaries of such unprecedented grand challenges. The National Academy of Science in the USA identifies five essential 21st century skills: *adaptability, complex communication/social skills, non-routine problem-solving, self-management/self-development* and *systems thinking* (National Academy of Sciences, 2010). These competencies are echoed in the UNESCO's report "Learning: The Treasure Within: Education for the Twenty First Century" (UNESCO's Report, 1999) and in a recent European Community's report which identifies eight key competences essential in a knowledge-based society (European Communities, 2007). The EU report emphasizes that these skills are not only critical in providing the flexibility in the labor force through allowing for quick adaptation to dynamic changes, but also serve as foundation pillars for innovation, productivity and competitiveness; proficiencies highly valued in a global world that has been encountering economic challenges in many of its countries (EU Report, 2007).

Research shows that the inadequate preparation of engineers in key competencies in fact extends internationally. A recent UNESCO report (Skills Gaps Throughout the World: an analysis for UNESCO Global Monitoring Report 2012) warns that skills gaps are constraining companies' ability to grow, innovate, deliver products and services on time, meet quality standards and meet environmental and social requirements in countries where they operate. The report identifies the lack of available talent and trained resources in the Middle East as the greatest threat for sustainable development of the region. Gulf leaders are among the least satisfied with the supply of employable graduates including engineers, with only 37 percent citing their satisfaction (Maktoum Foundation, 2012). Employability skills were classified into four categories (technical, cultural, interpersonal, and intrapersonal) and included fifteen specific skills: *independent task execution; appropriate approach to problem solving; ability to monitor and evaluate own activities; ability to relate specific issues to wider contexts; ability to apply knowledge to new situations; ability to devise ways to improve own actions; ability to deal with different cultural practices; openness and flexibility; negotiation and mediation skills; self motivation and initiative; ability to network; creativity and innovation; ability to relate to a wide range of people; team participation; and sense of identity and self confidence* (UNESCO Report, 2012). Misalignment between education and employers needs was cited as one of the main reasons behind the skills gap.

The current engineering curriculum, delivered by the vast majority of institutions worldwide including the Middle East, continues to follow the traditional science model of engineering education in which the first two years are typically devoted to basic sciences and mathematics, with minimal exposure to "real-world" engineering problems (Froyd and Ohland, 2005, Dym et al., 2007, Sheppard et al., 2009, Khalaf et al., 2013). Furthermore, engineering curricula continue to be mostly delivered by traditional passive lecture mode in which instructors start with theories and mathematical models, and then move to textbook

* Corresponding Author: Dr. Kinda Khalaf Tel.: +971-02-401-8107
E-mail address: kinda.khalaf@kustar.ac.ae

examples, which may or may not ultimately extend to real world applications (Prince and Felder, 2006). The combination of the traditional model of engineering education, which clearly delays student exposure to engineering integrative thinking and experience, with deductive passive course delivery leads to the current mismatch between the traditional structure of the engineering disciplines and the emerging complexities of modern engineering systems (Litzinger et al., 2011). Research shows that students will not develop the aforementioned competencies by following mostly theoretical, disconnected curricula while sitting passively in lecture halls, taking notes and memorizing content (Newstetter et al., 2012). Even more interactive methods such as Personal Response Systems or Student-centered Active Learning Environments for Undergraduate Programs (SCALE-UP) (Beichner, Saul, Allain, Deardorff, & Abbott, 2000), both of which promote greater student interaction, are not specifically designed to help students develop these competencies because the nature of the problems given students in traditional engineering classes, while a first step in becoming a successful engineers, are not sufficiently complex to allow students to practice essential 21st century skills (Newstetter et al., 2012). These challenges in developing countries, such as the United Arab Emirates (UAE), have more severe implications, given that the industrial sector is in its infancy, and hence has an even higher need for problem solvers, critical thinkers, and independent learners.

1.1. Biomedical Engineering: A Discipline Under Construction

The field of Biomedical Engineering (BME) lies at the intersection of engineering, medicine and the biosciences. As such, in addition to the typical challenges mentioned above, biomedical engineering education entertains its own unique challenges. Newstetter et al. (2010) summarize the challenges as ones encountered on two main fronts: the educator front and the student front. From the perspective of educators, biomedical engineering education needs to bridge the gap between engineering and medicine and hence must combine the design and problem solving skills of engineering with medical and biological sciences knowledge and skills. And yet, to date, almost no textbooks specifically targeting BME exist at the undergraduate level. The learning challenges on the student front are significant. Learners must master three traditionally distinct intellectual faculties: 1) modeling and quantitative skills required for engineering; 2) qualitative systems analysis skills integral to the life sciences; 3) clinical sensibilities inherent in medicine. It is therefore obvious that biomedical engineering educators need to foster in students the cognitive flexibility inherent in true integrative thinking and system analysis in order to embrace the merging of these distinct practices and historically-separated disciplines (Newstetter et al., 2010).

An additional set of challenges in the highly interdisciplinary biomedical engineering education stems from the dynamic nature and fast pace of evolution of this young discipline. Educators and students alike operate in a discipline with continuously shifting grounds and highly dynamic boundaries and constraints. The typical biomedical engineer of the 1970’s and 1980’s whose main training was in electrical or mechanical engineering with a few “picked up as needed” courses in biology and physiology did not need the skills crucial for today’s tissue engineer who works on designing entire organs from stem cells and hence faces a whole range of engineering, biological, clinical, and ethical complexities. The 21-century set of skills and competencies is not only critical here for innovation, productivity and competitiveness, but more importantly for maintenance and enhancement of the ultimate machine- the human body.

1.2. Problem-Driven Learning (PDL)

In response to the need for fostering the critical skills for successful modern engineers mentioned above, various pedagogical inductive learning models have started to make inroads into engineering education (Prince and Felder, 2006). These models include a wide spectrum of pedagogies ranging from discovery learning, and case-based learning to problem and project-based learning, active and cooperative learning and just in time lectures. The main feature shared by these models is the presentation of a specific challenge or complex problem to the students as the initial point of leaning after which they are coached to self learn upon recognizing the need for theories, facts, skills and concepts (Prince and Felder, 2006). Problem-based learning (PBL), as defined by H.S. Barrows who was one of the pioneers who developed and implemented PBL in medical education over three decades ago, is the learning method based on using problems as a starting point for the acquisition and integration of new knowledge (Barrows, 1986). As a pedagogy centered around problem solving of complex, open-ended, ill-defined and ill-constrained problems, PBL inherently aligns with engineering in which complex problem-solving is a main pillar, and offers engineering educators innovative and effective means to successfully engage students deeply with content (Capon & Kuhn, 2004), to apprentice them to the practices of a particular community, to practice a specific skill set such as spoken and written communication, and more importantly empowers them to assume responsibility to be self-directed and life long learners towards developing the necessary analytical and complex problem solving skills needed to tackle the multifaceted challenging engineering world of the twenty first century. (Johnson, 1999; Woods, 1996; Yadav, Subedi, Lundberg, & Bunting, April 2011).

For our purposes, we adopt a slightly different term—problem-driven learning (PDL). This term can be in essence interchangeably used with problem-based learning or PBL in our context. The word “driven” in PDL is used to replace “based” in PBL in order to emphasize the central role of complex problems in initiating and driving the learning process. In fact, we adopt this term from the research we have been doing in trying to understand reasoning, problem solving and learning in authentic sites of interdisciplinary practice---university research labs (Osbeck, Nersessian, Malone, & Newstetter, 2010). Over the last ten years we have investigated a tissue-engineering lab, a neuroengineering lab and two integrated systems biology labs using ethnographic research methods. We then sought to translate our findings on learning in those sites into new models for engineering education (Newstetter et al. 2010). We found in these sites of authentic engineering activity that learning is powered by the need to solve complex problems. Problem-driven learning fuels advances in knowledge and lab breakthroughs. However, the laboratory problems look nothing like textbook problems. They are complex, ill structured and ill constrained. They require the integration of knowledge and skills across the bioscience/engineering divide. Adapting to new and changing conditions both in terms of personnel, problem types and the ever-present impasses encountered in frontier science is a fact of life. Researchers need to navigate what, when and how they learn; they work collaboratively when the intractability of the problem demands a collection of heads and hands. Our investigations of these laboratories illuminated why BME majors need to practice early and often the skills of tackling, defining, constraining and working through complex, interdisciplinary problems to be able to effectively participate as complex problem solvers in industry or research. Thus the mantra of an introductory course in biomedical engineering needs to proclaim: *Empower students to be agents of their own learning who are fearless in the face of a complex problem.*

In this paper, we report on an experiment in transnational exchange and cooperation between Georgia Tech in Atlanta, Georgia USA and Khalifa University in Abu Dhabi around the design of such an introductory course in biomedical engineering. It is a story that has many twists and turns. Inspired by the success of the introductory BME course model developed at Georgia Tech. (GT) in Atlanta, a collaborative effort went into the design and development of a PBL introductory biomedical engineering course at Khalifa University (KU) in Abu Dhabi, UAE. Although the core of the PBL problems and scaffolding approach were adopted from GT, as well as the general course structure, the open-ended, ill-structured problems were specifically designed to "custom–fit" the KU and the UAE culture (Newstetter et al, 2012, Khalaf et al., 2013). In the process, the authors explored the design of an exportable system for PBL transfer across cultures. The main hypothesis lies in the successful globalization of PBL, through the design of a system for cross-cultural transfer based on the development of generic core problems with cultural-specific skins that address interdisciplinary skills unique to BME (Newstetter et al., 2012, Khalaf et al., 2013). This paper introduces this system (see appendix for definition of terminology).

2. PDL model at GT- the development of "generic" cross-cultural core problems

The development of a problem-driven learning curriculum at Georgia Tech commenced in 2000 as the newly founded Department of Biomedical Engineering was accepting its first PhD students. Faculty began by creating a first year graduate course that used the white board scaffolding found in Medical PBL in the context of six problems representative of the varied branches of biomedical engineering. Special PBL rooms were commissioned for the new BME building. In the following year, the first undergraduate course titled *Problems in Biomedical Engineering I* was piloted. Over the next three years, a number of new problems for this course were developed and run with student teams to determine their appropriateness and relevance for an introductory course in biomedical engineering. In time, three problems emerged from an iterative process of prototyping, running, analyzing and redesigning that we now consider as *cores* over which different *skins* can be affixed. To illustrate, the first problem focuses on screening or treatment in the context of disease (See example problem in appendix). The problem brings together probability statistics (sensitivity/specificity/positive predictive value) in health screening, issues of scale and systems in disease, and the development of quantitative methods of analysis for evaluation/decision-making in the face of conflicting and changing information. A significant intended learning outcome for the whole course generally but for this problem very specifically, is the development of efficient/effective inquiry skills, which are very much needed when sifting through the peer-reviewed journal articles. Each term, a new disease can be explored. Generally, skins would be one kind of disease or another (cancer, endometriosis and sickle cell disease have been typical problem skins at GT).

The second problem has experimental design at its core and the third has mathematical modeling and computer simulation. These core problems offer enough flexibility that each semester is very different for both students and faculty. For example, through modeling and simulation, students were asked one semester to determine what steps the campus should take to prevent the spread of H1N1 while the next semester they looked at the potential for experimental viral traps to halt the spread of HIV. This potential to "re-skin" the core problem each term with a different story line, a story line that often comes from current health and science news, keeps the course fresh and current for both faculty and students. Importantly, students really have the sense that they are working along side other biomedical researchers on significant problems rather than just doing homework sets from textbooks.

In conjunction with problem development, a rubric laying out the intended course learning outcomes and student behaviors was developed for facilitators to use in observing student behaviors on the teams and for students to self and peer assess. Rubrics for scoring each problem presentation and report as well writing guidelines for each problem were also developed. This collection of materials scaffold student activities across the problem making it possible for freshman teams to take on significant authentic problems. Finally, a strategy for a final exam was developed, piloted, evaluated and redesigned using the same "skin" concept as the problems. Prior to collaboration with Khalifa, the Georgia Tech team had reached a steady state whereby more than one hundred and fifty students were going through this experience every term facilitated by twelve or more faculty and post-docs a term.

3. Cross Cultural Globalization- the development of "cultural-specific" skins

The PDL model adopted at the Biomedical Engineering Department at Khalifa University is based on the system designed by GT in terms of *"the core"* problems described above. As previously mentioned, other attributes such as the scaffolding approach, the three problems per semester structure, as well as the general course structure were also maintained. On the other hand, what we refer to as *"skins"* or outer shells affixed to these open-ended, ill structured and poorly constrained core problems were specifically designed to "custom–fit" the KU and the UAE culture. The role of the facilitator is also is very different from an instructor. The facilitator is not an expert that provides information or directs the group towards a solution, but rather asks in depth probing questions at the process level in a guidance or scaffolding support role. This initial support is slowly reduced as the students develop greater proficiency and assume greater responsibility (Newstetter, 2006).

The following elements were incorporated in the process of the cross-cultural system transfer:

1. Problem Topics- Cultural Relevance: Motivation and Constraints

The topics were carefully selected based on cultural and societal relevance, emphasizing current health challenges in Abu Dhabi and the UAE. For example, as mentioned above, a typical core problem used at GT for the first problem is the identification of optimal methods for disease screening. In alignment with GT, this problem was selected due to the large amount of inquiry involved towards the solution ranging from the disease mechanisms at the molecular level, to the physics behind imaging technologies, to the protocols involved in a various screening, to the highly experimental research that has the potential to create new screening paradigms (Newstetter et al., 2010).

At KU, fresh skins were affixed to the core such that a cultural relevance and benefits were clearly established. For example the following two health challenges were selected at KU for problem one:

- Diabetes mellitus type 2: The United Arab Emirates has the second highest rate of type 2 diabetes prevalence in the world (19.6%), projected to increase to 63% by the year 2030.
- Obesity: The UAE has one of the world's highest rates in over weight and obesity (71% of men and women being either over weight (34%) or obese (36%)).

On the other hand topics such as HIV, drug abuse, or life support were avoided due to cultural constraints.

The main objective of the second core problem, which is typically related to investigating the accuracy of a particular (medical) device, lies in the design of an experiment meant to test a hypothesis. The team has to use the literature to develop a testable hypothesis. Then they need to develop an experimental protocol for collecting data to either verify or disprove their hypothesis. They must also design and set up an experiment so as to determine whether the results are statistically significant or not. Further, they need to determine what an appropriate sample size will be to achieve significance. And finally every team member has to individually become IRB certified and the group must get IRB approval beforehand (Newstetter et al., 2010).

An example of a skin affixed to such a problem at KU based on cultural relevance is *The Design and testing of an Intelligent Speed Control System.* Relevance is immediately established when the text of the problem states that Abu Dhabi has one of the highest rates of road deaths in the world amounting to an alarming 27.4 of 100,000 people, as compared to 15.2 in the US and 11.9 in the EU (HAAD health statistics, 2011).

2. Skill-based focus to promote metacognitive learning that is of particular importance yet nonstandard to culture

In addition to the skill deficiencies that engineering students suffer from on a global level (see introduction), students in a particular culture may require promotion/validation of certain skills, equally important for the modern engineer, yet lacking in that culture. One example is the empowerment of women in the UAE and the Arab world. Females in this part of the world typically attend all girl schools and aside from their male relatives do not interact socially with men. The PBL course is one of the first experiences in co-ed education and cross gender professional engagement, and hence provides an opportunity to promote women empowerment and leadership, through research on achievements of other women as related to the core problems, as well as particular focus on team and communication skills in a co-ed environment.

Another important skill that was particularly reinforced at KU is "learning to learn" or autonomous self-directed learning. Inherent to PBL, this skill is critical yet non-standard to a culture that mostly adheres to passive learning didactic lecture models and in which many students, particularly females, are the first generation in their family to attend college. Student teams were empowered to assume initiative and responsibility for their learning and were engaged in the selection, management and assessment of their learning activities. The main goal is to train life-long learners and independent thinkers equipped to undertake a leading role in a future knowledge-based economy.

3. Cultural-specific assessment-what works best in line of cultural values and constraints

Assessment in the PBL classes at GT targets four specific areas: self- directed inquiry, knowledge building, collaboration skills and problem solving strategies. Various alternative assessment methods are used cumulatively at GT towards assessing these skills through the semester. These include inquiry updates, post-problem self and peer evaluations, concept maps, written and oral presentations, and written assessment. While all of these are useful tools to monitor and assess the four target areas, cultural constraints may again play a role in the success of these assessment tools. For example, the concepts for peer and self-assessment at KU proved quite challenging, as specific cultural values resulted in systematic underestimation of the students of their own performance and overestimation of that of their peers. The solution (affixed skin) was to share the assessment rubric with the students and have them quantify each of the categories by developing "skill lines" as an instrument to gauge the progress. The students were hence engaged in the skill assessment and quantification throughout the problem cycle for each of the three problems in a quantitative manner that helped them overcome the cultural assessment constraint. This engagement helped them learn to calibrate and objectively gauge skills (both self and team members).

4. Conclusions

This paper reports on ongoing collaborative translational effort between Georgia Institute of Technology in Atlanta (GT) and Khalifa University of Science, technology and Research (KUSTAR) in Abu Dhabi around the design, development and implementation of an introductory course in Biomedical Engineering delivered using problem-driven learning (PDL). The main contribution of this work lies in the conceptual design of an exportable pedagogical system for PDL transfer across cultures. The system is based on the development of "generic core" problems that are specifically designed to promote the critical unique skills needed for biomedical engineers through scaffolded metacognitive apprenticeship, while ensuring the smooth and effective cross cultural transfer and relevance via affixing "cultural skins" to these problems. Future work includes the collection of comparative data using the system and the development of authentic assessment strategies.

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References

Barrows, H.S. (1998). The essentials of problem-based learning. Journal of Dental Education, 62(9), 630-633.

Beichner, R. J., Saul, J. M., Allain, R. J., Deardorff, D. L., & Abbott, D. S. (2000). Introduction to SCALE-UP: Student-centered activities for large enrollment university physics. Presented at the Annual Meeting of the American Society for Engineering Education, St Louis, Mo.

Capon, N., & Kuhn, D. (2004). What's so good about problem-based learning? . Cognition and Instruction, 22(1), 61-79.

Dym, .L. (2004). Design, Systems, and Engineering Education. International Journal of Engineering Education, 20 (3), 305–312.

European Communities. (2007). Key competences for lifelong learning. European Reference Framework Luxembourg Office for Official Publications of the European Communities.

Froyd, J.E., and Ohland, M.W. (2005) Integrated Engineering Curricula. Journal of Engineering Education, 94 (1),147-164.

Johnson, P. A. (1999). Problem-based cooperative learning in the engineering classroom Journal of professional issues in Engineering Education and Practice 125(1), 8-11.

Khalaf, K., Balawi, S. & Hitt G.W. (2013). Engineering design Education: Where, When and How. Journal of American Education, In Press.

Litzinger, T.A., Lattuca, L.R., Hadgraft, R.G., and Newstetter, W.C. (2011). Engineering Education and the Development of Expertise. Journal of Engineering Education,100 (1), 123-150.

National Academy of Sciences. (2010). Exploring the Intersection of Science Education and 21st Century Skills: A Workshop Summary. Washington, DC: National Academies Press.

Newstetter, W., Khalaf, K., & Xi, P. (2012). Problem-driven learning on two continents: Lessons in pedagogic innovation across cultural divides. Paper presented at the Frontiers in Engineering Education meeting, Seattle, Washington.

Newstetter, W., Behravesh, E., & Fasse, B. (2010). Design Principles for Problem-Driven Learning Laboratories in Biomedical Engineering Education Annals of Biomedical Engineering, 38(10), 3257–3267.

Osbeck, L., Nersessian, N. J., Malone, K., & Newstetter, W. (2010). Science as psychology: Identity and sense-making in science practice. New York: Cambridge University Press.

Prince, M.J., and Felder, R., M. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. Journal of Engineering Education, 99(4), 1-16.

Prince, M.J., and Felder, R., M. (2007). The Many Faces of Inductive Teaching and Learning". Journal of College Science Teaching, 36(5), 14-20.

Sheppard, S., Macatangay, K., Colby, A., & Sullivan, W. M. (2009) Educating Engineers: Designing for the Future of the Field. San Francisco, CA: Jossey-Bass Publishing Inc.

UNESCO's Report. (1999). Learning: The Treasure Within. from http://www.unesco.org/delors/delors_e.pdf

UNESCO's EFA Global Monitoring Report. (2012). Learning: Youth and Skills. from http://www.unesco.org/new/en/education/themes/leading-the-international-agenda.pdf

Woods, D. R. (1996). Problem-based learning for large classes in engineering education. In L. Wilkerson & H. Gijselaers (Eds.), Bringing problem-based learning to higher education (pp. 91-99). San Francisco, CA: Jossey-Bass.

Yadav, A., Subedi, D., Lundberg, M. A., & Bunting, C. F. (April 2011). Problem-based learning in electrical engineering. Journal of Engineering Education, 100(2), 253-280.

APPENDIX

Carcinoma of the pancreas has markedly increased over the past several decades and ranks as the fourth leading cause of cancer death in the United States. In 2011, of the estimated 44,030 new cases of pancreatic cancer, 37,660 will result in deaths (National Cancer Institute, 2011). The overall survival rate at all stages is <1% at 5 years with most patients dying within 1 year. At present there are no reliable screening tests for detecting pancreatic cancer in asymptomatic persons. The deep anatomic location of the pancreas makes detection of small, localized tumors unlikely during the routine abdominal examination. Even in patients with confirmed pancreatic cancer, an abdominal mass is palpable in only 15-25% of cases. Among healthy subjects, CA19-9, a serologic marker potentially used for screening, has good specificity---85% (Safi, Schlosser et al. 1996) but nevertheless generates a large proportion of false-positive results (positive predictive power 0.9%) due to the very low prevalence of pancreatic cancer in the general population. The predictive value of a positive test could be improved if a population at substantially higher risk could be identified.

Your team has been selected by the National Cancer Institute to investigate and evaluate current methods for pancreatic cancer screening, including the effectiveness of the most commonly used methods. You are then expected to identify and make recommendations regarding potential future screening strategies, which relative to current strategies enhance sensitivity without sacrificing specificity.

Safi, F, Schlossew,W, Falkenreck, S and Beger, H.G (1996) Ca 19-9 serum course and prognosis of pancreatic cancer. *International Journal of Gastrointestinal Cancer*. 20/3.

Terminology

Scaffolding: Providing sufficient support for students to operate at a higher level than otherwise possible. This typically includes facilitators' help (in the role of a coach or trademaster), score sheets, rubrics, and writing guidelines.

Skin: The storyline of the problem to frame it in a cultural/societal context as necessary.

Metacognetition: Learners' awareness of their own knowledge and their ability to understand, control, and manipulate their own cognitive processes.

The use of PBLMathGame as a Problem based learning tool.

Faaizah Shahbodin[1,] ,Zareena Rosli[1, 2]

[1]Department of Interactive Media, Faculty of Information and Communication Technology,
Universiti Teknikal Malaysia Melaka,Locked Bag No. 1752, 76109 Durian Tunggal, Melaka,Malaysia.
Phone: +606 3316740 Fax: +606 3316500

[2]Department of Mathematics Science and Computer,
Politeknik Merlimau,Melaka, Locked Bag No. 1031, 77300 Merlimau,Melaka,Malaysia.
*

Abstract

This paper revealed the framework of PBLMathGame prototype and discussed the effectiveness of using game as a tool in PBL environment. The development of the PBLMathGame is based on the skills needed in problem solving in Related Rates topic. By understanding the relationship between educational needs and game elements, the PBLMathGame is developed that include visualisation and problem solving skills. The experiment was carried out for two weeks involving 28 students who enrolled into Engineering Mathematics 2 course. The experimental group (EG) was exposed to PBL and Educational Game instruction whereas the control group (CG) was taught by PBL only. There are two set of instruments used in this study namely PBLMathGame courseware, problem solving answer sheets and rubric sheets for problem solving. The data were analyzed using independent t-test. The result showed that students improved their problem solving skills in solving Related of Change problem when incorporating game in their learning. Thus, this study has shown some value added to the area of PBL learning.

Keywords: Education game;Problem based learning;Mathematics; PBL tools

1. Introduction

Playing games is a common skill to our social and mental development. According to YanHong *et. al*. (2010) and Costu *et. al*.(2009), with the advent of computer technologies and internet, games can be used for the development of education area. Nevertheless, with the rapid technological innovation that influence competencies, knowledge and skills, there is a need for pedagogical change in Malaysian education program Zakaria *et.al*.(2010).

Problem Based learning (PBL) is the integration of specific concepts and classroom contexts for enhancing students' critical-thinking skills and problem solving ability. Moreover, the challenge of globalisation today requires students to master problem solving skills and positive attitude and values besides good conceptual knowledge of mathematics. PBL also serves as a powerful tool in empowering learners to have a sense of control of their learning Tan and OS (2004).

In order to obtain the cognitive and affective benefits of educational games in the classroom, a well-designed educational game needs to be grounded in the prototype. In this study of PBL, the game was used as one of the learning resources for students to learn Related Rate topic. The game developed intended to develop and improve students' skill in problem solving especially in developing mathematics concept and procedural knowledge among students. The PBLMathGame was designed as an in class activity to assess students understanding of Related Rate topic. In a research conducted by Martin (2000), the result shows that while performing problem solving, students are proficient in performing algorithms, but lack of ability to connect procedure with their conceptual knowledge. The inability to connect both knowledge was the thought of students' difficulties in higher level mathematics (Zahrah et. al. and Ismail, 2009; Tarmizah, 2005). Thus, an initiative of integrating game in PBL environment has been taken to improve student's quality in problem solving skill in mathematics.

In this paper, we will describe the prototype of PBLMathGame created to enhance students' skills in mathematics problem solving and to assess the impact of PBLMathGame in enhancing students' skills in problem solving based on rubric scores. The game consists of content that develop student's knowledge in relating mathematics concept and procedural steps in solving related rate problems. The game design, create a game environment that allowed players to learn Related Rate topic while having fun with the game and interactive environment as game in education has shown improved motivation and students' engagement and improved participation and achievement (Ishikan et. al. and Yan Hong et.al., 2010, Papastergiou, 2009 and Alan et.al., 2000).

2. PBLMathGame Prototype

The game was used as an in-class activity to assess students understanding of Related Rate topics. In the PBL environment, the game was embedded in the learning resources, for the students to practice and learn problem solving in Related Rates word

* * Corresponding Author : Zareena Rosli. Tel.: +606-2636687
E-mail address: zareena703@yahoo.com

problem. The settings of the game started with questions on mathematics concept that covers diagram sketches and understanding mathematics notation from word problem. Then, for the medium level student will be tested on understanding conceptual and procedural steps in related rate problem and the higher level they will be asked to solve real life problem. Throughout the game, students are going to solve each level's question based on their understanding of the topic. The questions developed emphasized on assessing students' ability in problem solving. At the end of the game, the score will be posted to the score board for assessing student level of knowledge in solving each problem. This game activity can be used as a class activity or it can be played individually. Therefore, the student can freely try the game; find out their mistakes with discussing with peers, facilitators or searching information from other sources provided in the courseware or by internet. By this way, the student can learn from their mistakes to solve the problem. Figure 1 and 2 shows the interface of the game

Figure 1. Introduction page for PBLMathGame

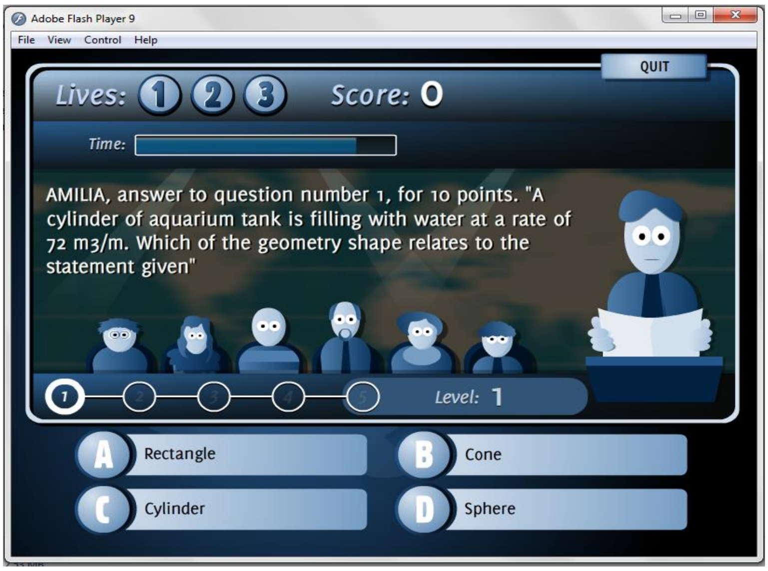

Figure 2. One of the questions for PBLMathGame

3. Method

In order to meet the objective, a prototype courseware PBLMathGame has been developed. There are 28 students from Year 2 who participate in this research. The students were divided into two groups; experiment group (EG) and control group (CG). They are equally in term of academic achievement. Both groups will undergo PBL learning method but for the EG, there is a game use as one of their learning resources. Students' skills in problem solving were tested by during problem solving session. An answer sheet will be given to each student for the solution answer and a rubric scores for problem solving is used to evaluate their scores. A t-test was conducted to analyze the mean scores between each group. Below is a list of research question and research hypothesis in order to achieve the objective:

Q1: Is there any significant difference in term of problem solving skills between PBLGame group and non-PBLGame group?

H_0 1: There is no significant difference in term of problem solving skills between PBLGame group and non-PBLGame group.

In order to answer the research question, a testing model has been developed as shown in Figure 1.

The problem solving rubric was used to evaluate the students' answer. The score of the students were evaluated based on 6 constructs on the ability of problem solving which is i) Diagram and Sketches, ii) Mathematical Terminology and Notation, iii) Mathematical Concepts iv) Strategy/Procedures, v) Mathematical Reasoning and iv) Completion. The resulting are starting score from 1(Beginning), 2(Developing), 3(Accomplished) and 4(Exemplary).

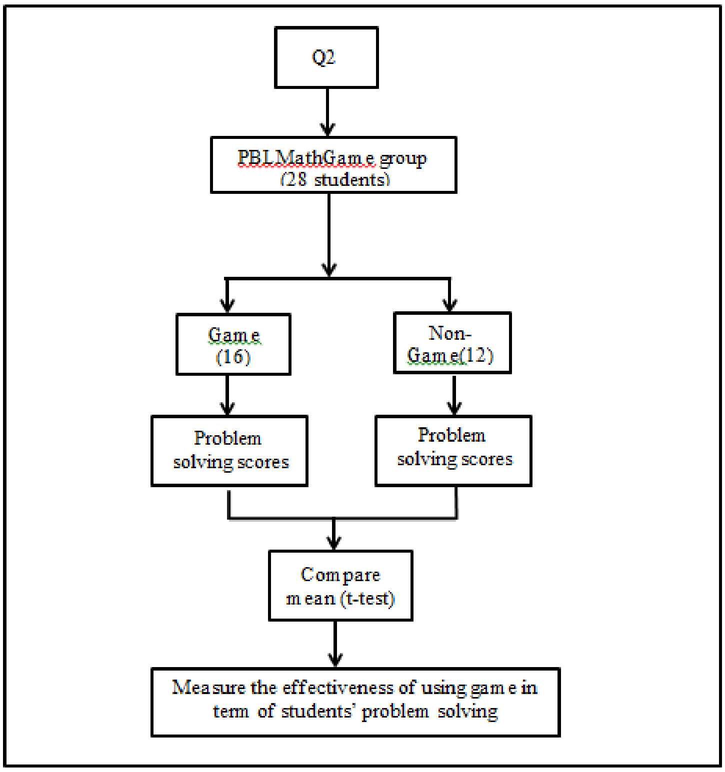

Figure 1. Testing Model for using game in integrating problem solving skill

4. Result and Discussion

Enhancing Students' Skills in Problem Solving: The purpose of study was to determine the effect of educational game (PBLMathGame) in enhancing students' skills in problem solving. There were 28 students participated in the study. They were divided into two groups namely PBLMathGame group and non PBLMathGame group. During the problem solving sessions, both groups were evaluated by a rubric score. These scores were used to determine the impact of game use in the learning session. The result of the study is shown in Table 1.

From the result, it shows that students in PBLGame are more competent in (i) identifying diagram and sketches (M=3.88, SD=0.34) compared to PBL-nonGame (M=3.5, SD=0.52) conditions $t(26)=2.30$, $p=0.30$. The game content that challenge students on identifying geometry shape is believed helps the student on identifying shapes as well as able to sketch it correctly. The result also shows that there was a significant difference in the scores for item (ii) mathematical terminology and notation between PBLGame (M=3.69, SD=0.47) and PBL-nonGame (M=3.17, SD=0.83) conditions $t(26)=2.09$, $p=0.047$. The game content that provides students with sort of mathematics notation and terminology established student’s capability in knowing tu use it correctly. Lastly on item (iii) mathematics concept, the result reveals that there is a significant difference PBLGame (M=3.63, SD=0.50) and PBL-nonGame (M=3.08, SD=0.79) conditions $t(26)=2.22$, $p=0.036$.

Table 1. T-test result for problem solving skills

Independent Samples Test

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
Diagrams and Sketches	Equal variances assumed	2.297	26	.030
	Equal variances not assumed	2.164	17.844	.044
Mathematical Terminology and Notation	Equal variances assumed	2.087	26	.047
	Equal variances not assumed	1.936	16.364	.070
Mathematical Concepts	Equal variances assumed	2.215	26	.036
	Equal variances not assumed	2.077	17.404	.053
Strategy/Procedures	Equal variances assumed	.450	26	.656
	Equal variances not assumed	.469	25.998	.643
Mathematical Reasoning	Equal variances assumed	.156	26	.877
	Equal variances not assumed	.158	24.717	.876
Completion	Equal variances assumed	1.138	26	.265
	Equal variances not assumed	1.130	23.203	.270

5. Conclusion

The result of this study shows the element of game in PBL can foster student in learning. With the element of critical thinking, self-exploration and group discussion while playing the game in PBL environment helps them in the learning process. Thus, supports that games can give impact in enhancing students' problem solving skills in mathematics. As a conclusion, building a creative learning environment such as leveraging PBL and game can foster students' interest in learning and improves their capability in learning. Hence it will help the education ministry in producing a knowledgeable and skill able engineers in future.

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References

Akinoglu, O., and R. O. Tandogan. (2007). The effects of problem-based active learning in science education on student's academic achievement, attitude and concept learning. Eurasia Journal of Mathematics, Science and Technology Education, 3(1): 71-81.

Alan A., N. Kevin, V. Jacky and A. Claudia. (2000). The use of computer games as an educational tool: Identification of appropriate game types and game elements. British Journal of Educational Technology. 30(4):311-321.

Coştu, S., Aydın, S., & Filiz, M. (2009). Students' conceptions about browser-game-based learning in mathematics education: TTNetvitamin case. *Procedia-Social and Behavioral Sciences*, *1*(1), 1848-1852.

George, Watson University of North Carolina. (2002).Technology to Promote Success in PBL courses. Retrieved December 2012 from http://technologysource.org/issue/2002-05/

Ishikan, U. and M. Sevgi. (2010). A short view on the relationship of mathematic and game from literature context and concept of educational mathematical game. World Applied Sciences Journal, 9(3):314-321.

Papastergiou, M. (2009). Digital game-based learning in high-school computer science education: Impact on educational effectiveness and students' motivation. Computers and Education, 52(1):1-12.

Tan, O.S. .(2004). Editorial. Special issue: Challenges of problem-based learning. Innovations in Education and Teaching International, 41 (2), 123-124.

Yanhong, Wang, Luo Liming, and Liu Lifang. (2010). The innovation of education brought forward by educational games. *Education Technology and Computer Science (ETCS), 2010 Second International Workshop on*. Vol. 2. IEEE.

Zakaria, E., C.C. Lu and M.Y. Daud .(2010). The Effects of Cooperative Learning on Students' Mathematics Achievement and Attitude towards Mathematics. Journal of Social Sciences, 6(2): 272-275.

PBL Applications in the BBA Programme in Business Administration in the School of Business and Services Management at JAMK University of Applied Sciences, Finland

Ritva Pyykkönen [a *], Sami Kalliomaa [b]

[a]*Rajakatu 35, Jyväskylä 40200, Finland*
[b]*Rajakatu 35, Jyväskylä 40200, Finland*

Abstract

The first aim of the present study was to describe three different Problem Based Learning (PBL) applications utilized in 2004 to 2012 in the Business Administration programme in the School of Business and Services Management at JAMK University of Applied Sciences, Jyväskylä Finland. These three PBL applications were: Transforming a Business Administration Programme into a Problem Based Learning Curriculum, Finnish Products in Foreign Markets, and a publication process using the Freinet PBL method. The second aim was to discuss the learning outcomes in the form of student experiences from using the PBL framework.

Keywords: PBL learning, PBL application, business learning competence

1. Introduction

The present study focuses on three kinds of PBL applications. The first application, transforming a BBA Programme in Business Administration into A Problem Based Learning Curriculum was started in 2004. The students complete all of their basic studies (60 ECTS) during the first academic year in a PBL context. The second PBL application, Finnish Products in Foreign Markets, discusses teacher exchange in 2006 to 2012, in which the network of firms, teachers and students were utilizing the PBL method. The third application describes how to use the Freinet PBL method in sales studies. The issue is approached by using curriculum descriptions and written empirical material, individual reports, group presentations and the feedback given by the students. The empirical material is mainly explored using a qualitative content analysis.

The pedagogical strategy of JAMK University of Applied Sciences accentuates the use of innovative pedagogical methods. The School of Business and Services Management have applied the PBL method. The issue of this study is to describe three different models of Problem Based Learning (PBL) applications that the BBA program in Business Administration in the School of Business and Services Management at JAMK University of Applied Sciences, Finland was utilizing in 2004 to 2012 and discuss the learning outcomes as student experiences using a relevant background of the PBL framework. The first application, Transforming a BBA Programme in Business Administration into A Problem Based Learning Curriculum, was started in 2004. The students completed all of their basic studies (60 ECTS) during the first academic year in a PBL context. The second PBL Application, Finnish Products in the Foreign Markets, discusses teacher exchange in 2006 to 2012, in which the network of firms, teachers and students were utilizing the PBL method. The PBL process used Finnish products as triggers. Finnish firms wanted to find out how the PBL method can produce business ideas and promote the possibilities of the Finnish products in the foreign markets. The third application describes how to use the new method of Freinet PBL in sales studies. The specific objective was to acquire the central knowledge of sales both in theory and practice. The teacher's objective was to develop an innovative way of learning by writing a publication.

2. Background theory

This study is based on the theoretical background provided by the pedagogical framework of Problem Based Learning. Several schools and disciplines have for years been promoting BPL, mostly through applications in medical and nursing education (Portimojärvi, 2006). Fagerholm and Helelä transformed a BBA Program in International Business into a PBL curriculum. The PBL approach is based on solid academic research on learning and on the best practices that promote it. Fagerholm and Helelä state that the PBL approach stimulates students to take responsibility for their own learning. “PBL is

*Ritva Pyykkönen. Tel.:+358-4057-69-371
ritva.pyykkonen@jamk.fi

unique in that it fosters collaboration among students, stresses the development of problem-solving skills within the context of business practice, promotes effective reasoning and self-directed learning, and is aimed at increasing motivation for lifelong learning.”. (Fagerholm & Helelä, 2003.) PBL and the development of leadership skills have been discussed by Mierson and Freiert (2004). Hansen shows how an accounting problem can be converted to a PBL problem. Wee and Kek (2004) rewrite business education through PBL. PBL applications in disciplines of education such as nursing, social health care, law, business, machine industry, architecture were described by Boud and Feletti (1999). The University of Maastricht developed its undergraduate curriculum in marketing and management around PBL (Hansen 2006, 221). Theoretical evidence of the usefulness of PBL in marketing and business management can also be found (see e.g. Hansen 2006, 22; Fagerholm & Helelä 2003; Wee & Kek 2004).

Table 1.Average Retention Rate of Different Teaching and Learning Approaches (Learning Pyramid by National Training Laboratories)

Teaching and Learning Approaches	Percent
Lecture	5 %
Reading	10 %
Audiovisual	20 %
Demonstration	30 %
Discussion Group	50 %
Practice by Doing	75 %
Teaching Others	80 %

The classic Learning Pyramid summarizes the results of the research conducted by National Training Laboratories in Bethel, Maine in 1994. (Table1). The retention rate varies enormously for different teaching and learning approaches. According to the Learning Pyramid, the best teaching and learning approaches are practice by doing and teaching others. A PBL graduate is able to apply what has been learned (Knowledge), reason and solve problems (Skills), conduct lifelong learning (Skills), work in teams (Skills), communicate (Skills) and uphold the values, ethics and professionalism of his/her professional practice (Attitude). The skills, knowledge and attitude comprise the profile of a PBL graduate (Figure 1).

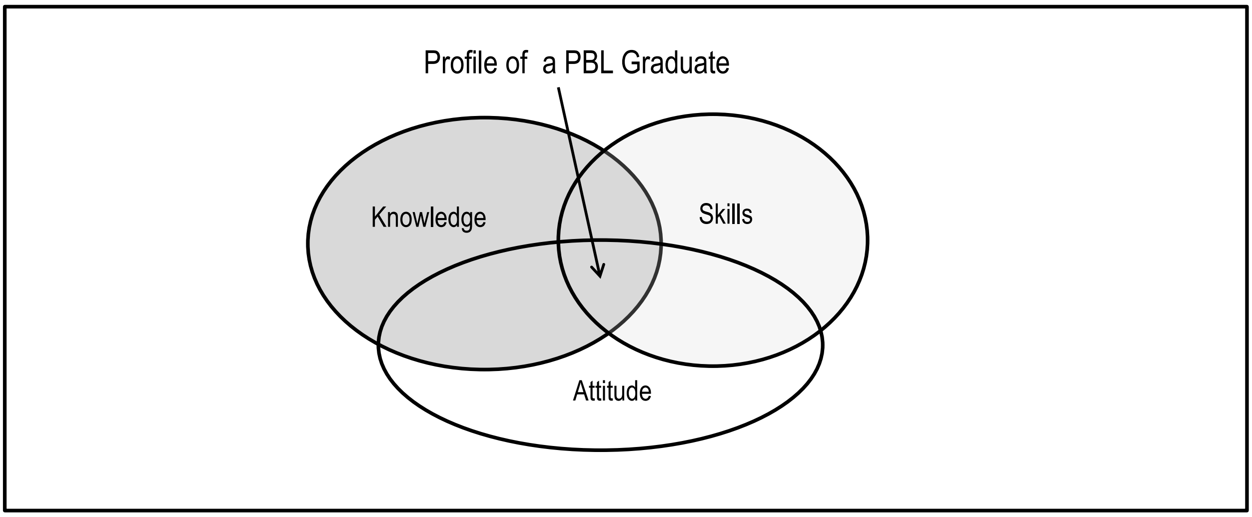

Figure 1. Profile of a PBL graduate

Prince, Van Eijs, Boshuizen, Van Der Vleuten & Schephier (2005) have reported graduates' opinions about how often they use competencies in their work. The research group compared the opinions of junior doctors of problem-based learning (PBL) and non-PBL schools and analyzed the responses to the questions in a questionnaire survey of 1159 graduates from 1 PBL school and 4 non-PBL schools. The survey had been conducted 18 months after their graduation. The competencies were Expert knowledge, Profession-specific skills, Computer skills, Communication skills, Teamwork skills, Planning and organization skills, Leadership skills, Independence, Creativity, Initiative, Dealing with change and Accuracy. According to Prince et al. (2005), a statistically significant higher usage by PBL graduates was found for expert knowledge, profession-specific skills and communication skills. Compared with their non-PBL colleagues, the PBL graduates gave higher ratings for the connection between school and work, their medical training and preparation for practice. More PBL graduates than non-PBL graduates indicated that they had learned profession-specific methods, communication skills and teamwork at school. (Prince et. al 2005.)

3. The first application: Transforming a Business Administration Programme into a Problem Based Learning Curriculum

Transforming a BBA Programme in Business Administration into A Problem Based Learning Curriculum was started in 2004 and it ended in 2008. The Degree Programme in Business Administration followed the pedagogical strategy and took the challenge of innovative learning methods. The students complete all of their basic studies (60 ECTS) during the first academic year a PBL context. The annual intake is 102 students. The students also complete their basic studies (60 ECTS) during the first academic year in a PBL context. The aim of the basic studies is to create a common ground for the elective professional studies (90 ECTS Cr) (Table 2).

Table 2. Structure of the Studies in Degree of Programme in Business Administration

Structure	ECTS Cr
Basic Studies	60
Professional Studies	90
Elective Studies	15
Practical Training	30
Bachelor's Thesis	15
Total	210

In the first academic year, the students solve problems in the areas of entrepreneurship, business economics, business law, marketing, marketing law, accounting, management, human resource management and international business (Table 3). The problems presented in a PBL context are either real-life problems presented by enterprises and the students or selected and designed by a group of teachers according to the specific learning outcomes to be achieved.

Table 3. Periods, Tutor teams and the Problems of the first Academic Year in a PBL context

Periods	Period 1	Period 2	Period 3	Period 4
Disciplines	Entrepreneurship Business Economics Business Law	Marketing Marketing Law Accounting	Management Human Resource Management Accounting	International Business
Tutorial Teams	3 Tutors	3 Tutors	4 Tutors	3 Tutors
Problems	3-5	5-8	5	4

The weekly schedule was made up of lectures, tutorials, self-study, group work, group presentations and exams (Table 4).

Table 4. Weekly Schedule of the first Academic Year in a PBL context

Monday	Tuesday	Wednesday	Thursday	Friday
Lecture Self-study	Project work Self-study	Tutorials 6 tutorial groups Workshop	Lecture Project work Self-study	Group presentations Exams

The problems (triggers) in the Basics of Marketing and Marketing Law were based on real business cases, normally written by a group of tutors (Table 5). The goal was that all the disciplines of the on-going (or former) periods include a trigger.

Table 5. Problems in the Basics of Marketing and Marketing Law

Problems	Subjects
Problem 1	Direct Marketing and Marketing Law
Problem 2	Product Development and Marketing Channels
Problem 3	Advertising Sales Promotion Public Relations and Marketing Law
Problem 4	Personal Selling
Problem 5	Marketing Plan and Programme

3.1. The Main Experiences of the PBL Curriculum in the course Basics of Marketing and Marketing Law

Table 6 shows the students' learning outcomes from the course Basics of Marketing and Marketing Law. At the beginning and at the end of the course, the students were given one written question "What is marketing?" The research time was the 2nd period in the autumn of 2005. The respondents were first year students (n=87). The answers were reported using a qualitative content analysis by classifying the marketing concepts based on the definition of marketing by Kotler & Keller 2009. Table 6 shows how many times a student has recognized each concept.

Table 6. The transformation of the marketing concept during the course Basics of Marketing and Marketing Law

Frequencies **Marketing concepts**	**Before**	**After**	**Change**
Product/Service	5	15	+10
Price	1	15	+14
Place	3	26	+23
Advertising	90	77	-13
Personal Selling	25	35	+10
Sales Promotion	9	23	+14
Public Relations	26	22	-4
Marketing mix; Marketing plan; Relations to accounting and human resource management	6	88	+82

The main result of using the PBL Curriculum in the course Marketing and Marketing Law was related to how the concept of marketing had changed. At the beginning, the students said that marketing was only about advertising and selling. At the end of the course, the students seemed to have a deeper understanding of marketing and its relations to accounting and human resource management (Table 6).

4. The Second PBL Application: Finnish Products in the Foreign Markets in 2006 to 2012

The goal of the second PBL application is to indicate how the network of firms, teachers and students is utilizing the PBLmethod in teacher exchange. In 2006 to 2012, two teachers visited universities in Brazil, Turkey, Slovenia, Germany, Croatia, Italy, Spain and France. The real business life triggers were given by the Finnish companies Panda, Harvia, Globe Hope, Kalevala jewelry including several design factories and a shoe factory. The informants of the study were students of the partner University of the JAMK University of Applied Sciences.

Figure 2 shows the steps and the weekly schedule of the PBL Application in teacher exchange. The used pbl steps were brainstorming, classification of ideas, defining the problem and the learning task, individual processing, collaborative problem solving and presentation. The study week starts on a Monday with a short lecture on International Marketing. After the week.

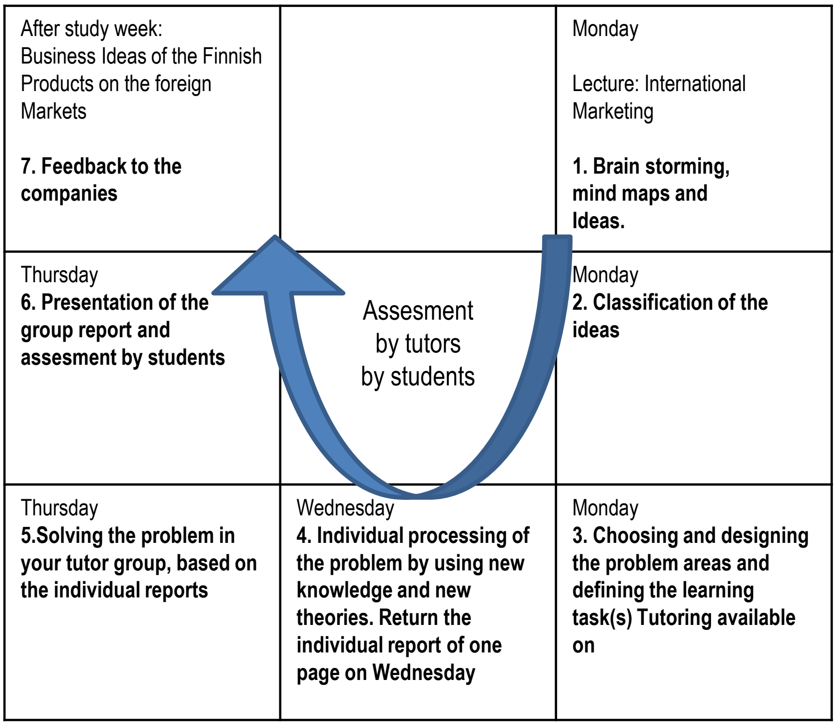

Figure 2. The PBL Application Finnish Products on the foreign Markets

4.1. Results of the PBL Application

In Genoa, the students' task is to find out the business ideas of the Finnish products Harvia sauna and Panda licorice in the Italian markets. The triggers were sauna oven brochures and Pepe licorice. After the classification of the ideas, the groups formulated their learning tasks as shown below. The students recognized the international marketing concepts of the of product adaptation, tools of marketing communication, the selection of the customer segment and the nature of customer behavior (Albaum & Duerr 2008). The learning tasks in Italy were:

- how to make "Panda" very popular among kids,
- how to reintroduce licorice culture in Italy,
- how to make sauna an everyday activity for everybody in Italy.

In Sevilla, the PBL trigger was Finnish shoe factory. The table 7 shows the results of the brainstorming. The ideas were classified into the groups of marketing communication, product attributes and product collection and price.

Table 7. The Classification of the brain storming ideas for marketing Finnish shoes

Ideas	**Classification criteria**
The commercial name is difficult for Spanish pronounciation	*marketing communication*
worldwide ad	
logo and sentences	
to sell the shoes it is necessary to show on tv and social networks by celebrities by internet	
symbols for the brand more beautiful	
For introducing in Spain:Program (tv), Fana, Big Brother, Famous Persons, Networks	
water-proof?	*product attributes and collection*
product for all sizes	
not only do shoes and bags	
Problem: Irregular weather in Spain	
These shoes are red and it's made of ecologic material	
This product is for cold country because you have to keep your feet warm- maybe these shoes can be used in north of Spain	
it's great for stay at home because these shoes are comfortable	
An innovative collection combining traditional, different and very original	
ideal for the childrens	
Fashion in Spain? it is an original product	
in Spain you won't find another similar	

Itchy	
low prices	*price*
Value for money	
Standard price (Rival products)	

The students gave proposals to Finnish companies in Germany. In their report, the students summarize the results of *positioning the brand* KALEVALA-Jewelry. "The main instrument for branding KALEVALA is advertising, opera, musicals or theatre events and product placement." The students suggested a *brand slogan* "bold, timeless and genuine" and define *the target group* as middle class women. "We are all convinced that advertising KALEVALA effectively needs mass media, like TV spots, radio spots or magazines." The students in Germany gave proposals to Globe Hope. Globe Hope is an innovative Finnish design company that makes ecological design products from recycled materials. *Target group and price*: "The products of the Globe Hope have to be sold to ecologically minded people, who are interested in ecological and environmental issues. These people have to be rich or at least wealthy because the products are placed in a high price segment. We think these people should be older than 25 and younger than 40 years old because they are more interested in such products." *Distribution channels*: "The product of globe Hope has to be sold in small so called third world shops or via the Internet. *Communication strategy:* "Globe Hope has to be identified as a world saving company and globe Hope has to communicate these strategies to the customers. The supported projects in particular have to be communicated in a better way." *Competitors*: "Before Globe Hope start to penetrate the German market, they have to know more about the potential competitors."

4.2. Student feedback

All the students gave strongly positive feedback about the new way of PBL learning. They like to find solutions for problems and they also liked group work and the real business cases.

"This experience was really interesting and satisfying and intercultural. Is has been a great time opportunity to revive my English and be in touch with the Finnish teaching method. Thank you for this great opportunity." "Let's have a sauna bath with the Panda licorice"

"First of all thank, you for this possibility. This experience has been very useful and satisfying. I got familiar with a new way of learning found it interesting, and I think I improved my knowledge of on the subject and my English, too."

"It was a different session, which I enjoyed a lot because I had the opportunity to compare my ideas with other students. Thank you for the opportunity you offered to us."

"I liked this kind of experience because for me is so useful to work in group with other students and explain the work done by a presentation."

"It is a useful method to learn, a new method to work making experience of group work. It's fun to try to seek solutions for problems."

5. The third PBL application: a publication process using the Freinet PBL method in sales studies

The sales study module was carried out using a new method. The special objective was to learn the basics of selling both in theory practice. The teacher's objective was to develop an innovative and interesting way to learn. A publication was created as the final result. The Freinet pedagogy and problem based learning were utilized. The publication consisted of articles consisting of clear-cut theory and research parts.

The method of learning can be named "Freinet Pbl Method". Freinet developed his own method of learning in the beginning of the 1900's. In 1923 Freinet purchased a printing press. Originally the aim was to assist him in teaching. The students would write their own works on the press. In this method, the learner has the responsibility for the learning. The students gather information, discuss and edit them as a group before presenting and printing them as a team effort. The Freinet pedagogy is based on the principle of the students learning best through their own experiences by doing, observing and writing. The learning takes place through motivating and sensible tasks.

Constructivist pedagogy is another foundation of this new learning method. At the initial stage, we utilized a problem based learning approach. Every group of 4-5 persons was given a problematic sentence, a so-called trigger which is related to selling. On the basis of the trigger, every group (nine groups in all) developed a learning task for themselves. Table 8 illustrates the examples of triggers, learning objectives and final names of the articles provided by two groups.

Table 8. Two examples of different triggers, learning objectives and final names of articles

Trigger	Learning objective	Final name of article
Salesteam success depend on co-operation	What is role of teamspirit and individualized work to team´s success?	Individual salesman have a great impact to team´s success
Salesman can affect a lot of customer decision.	What kind of salesprocess do we need to influence customer decision?	Quality Salesprocess

Every student had about seven weeks for writing a theoretical article. In the next meeting, a synthesis was made of the contents of these articles. In this meeting, students also made a decision which company and what kinds of methods they would use to gather practical information on the problem and theory. The students got instructions but they were also responsible for their own decisions and solutions. For this, they were given four weeks.

Figure 3 shows the process of the“Freinet PBL” learning circle. The learning circle includes five stages: 1) introducing a problem, 2) a group discussion, 3) resource development, 4) a group reflection and 5) the solution and presentation. The learning process will generate a memo, individual report, group report and presentation. The main goal is to edit the group report and write an article for a mutual publication.

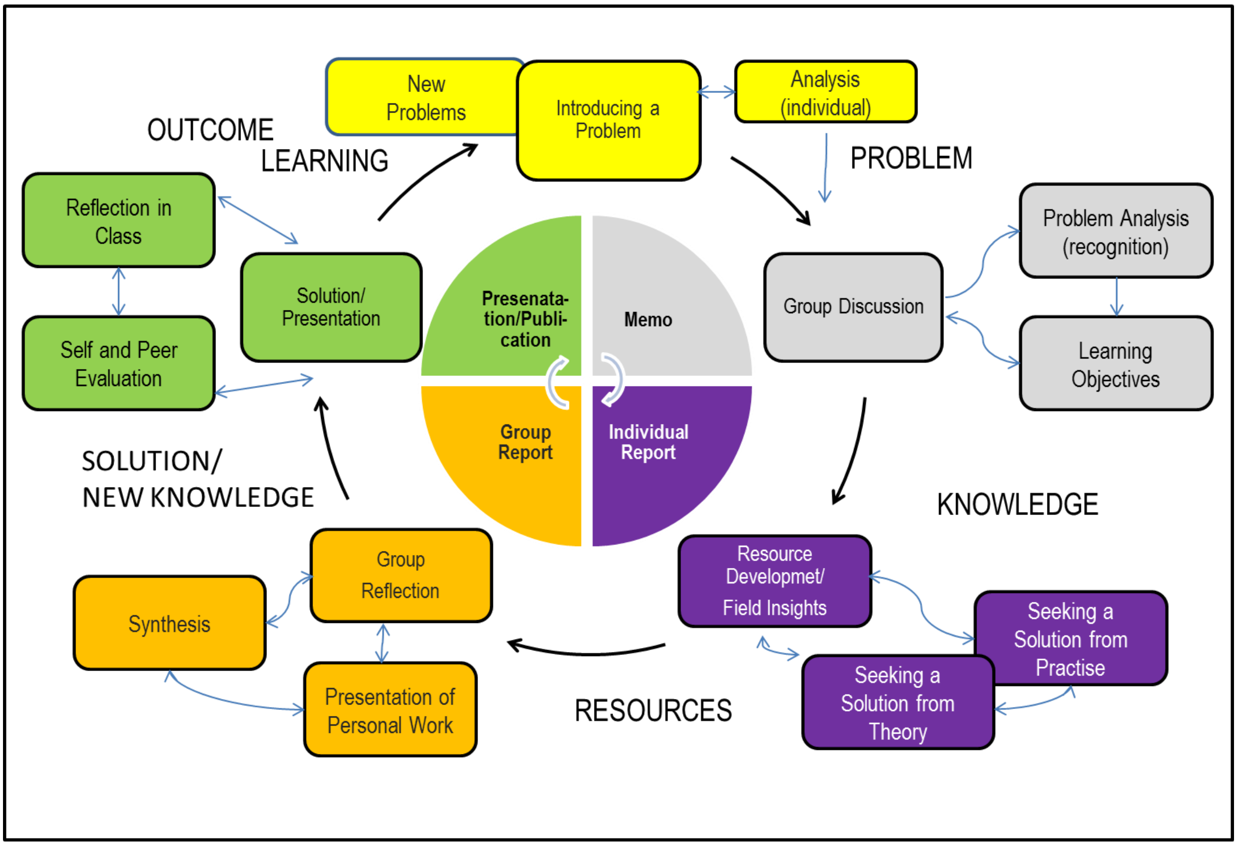

Figure 3. The process of the “Freinet-PBL” learning circle

5.1. Results of the PBL Application

As a final result, the publication ”Interaction in the selling” was created. The articles consist of diverse subjects, for example stages of a successful sales process, a productive way in solution sales and the significance of feelings in sales. Everyone presented the central results of their own article. The students experienced a new, very different way to learn. The majority of them were extremely positive. In their opinion, the study method was a motivating and responsible way to learn. There were also those who experienced this new way a really laborious way to learn. The new method of learning requires a tolerance for uncertainty during the process of both student and teacher. At the end of the study module, every student got their own publication.

Figure 4. The new publication: “Interaction in Selling – keys to selling, 2011”

6. Conclusions

We are presenting the following as a summary of the PBL applications. The main result of using the PBL curriculum in the course Marketing and Marketing Law was the diversification of the concept of marketing. At the end of the course, the students seemed to have a deeper understanding of marketing and its relations to other disciplines, for example accounting and human resource management.

The study of the Finnish Products on the Foreign Markets shows that the PBL application works in business learning and in the internationalization process of firms. Finnish firms have got new information of the foreign markets. In most of the universities visited, the PBL method was unknown. Even group work was a new thing in learning. As for the mplications, contribution or relevance of the study: This study brings out practical results based on native information of the foreign markets and gives a contribution to business education and international marketing.

The new way to learn selling using the "Freinet PBL method" was, mainly, an extremely positive learning experience to the students and the teacher. The students wrote high-quality theoretical articles based on their observations and the research material from the firms studied. The students learned from each other, and the teacher's role was to be a trainer and the controller of the learning. The students' role was extremely independent and responsible. The Freinet PBL method fulfilled the promise of the University of Applied Sciences to combine theory and practice. Next goal could be to explore this method using a new technical device (I Pad) and write an online book.

This article shows the innovativeness of the applications of the teaching methods in the School of Business and Service Management. Future research is needed to find out the broader impacts of the PBL applications. The PBLmethod makes it possible to strengthen the network between firms, students and universities. The parties can interact with and influence each other. Perhaps the parties will be co-creating business developing programs in the future. (see Vargo & Lusch 2004.)

References

Albaum, G., & Duerr, E. (2008). *International Marketing and Export Management*. Gosport: Ashford Colour Press.

Boud, D., & Feletti, G.I. (1997). *The Challenge of Problem-based Learning.* 2nd ed. London: Kogan Page Limited.

Fagerholm, H., & Helelä, M. (2003). *Handbook for transforming a BBA program in international business into Problem Based – Learning Curriculum; Case: Liibba Program at Helia.* Helian julkaisusarja A:8.

Hansen, J.D. (2006). Using Problem-Based Learning in Accounting. *Journal of Education for Business,* 81 (4), 221-224.

Kotler, P., & Keller, K. L. (2009). *Marketing Management*. (13rd et.). New Jersey: Upper Saddle River.

Mierson, S., & Freiert, K. (2004). *Problem-Based Learning.* (pp.15-17). American Society for Trainong & Development.ASTD.

Prince, K.,Van Eijs, P., Boshuizen, H., Van Der Vleuten, C., & Schephier, A. (2005). General competencies of problem-based learning (PBL) and non-PBL graduates. *Medical Education*, 39,(4), 394–401.

Potimojärvi, T. (ed.) (2006). *PBL Ongelmaperustaisen oppimisen verkko*. Tampere: Tampereen yliopistopaino.

Rasinkangas, A. (2004). *Matka ongelmalähtöiseen oppimiskulttuuriin.* Hämeenlinnan ammattikorkeakoulun julkaisu A:2/2004. Hämeenlinna.

Vargo,S.L., & Lush,R.F., (2004). Evolving to a New Dominant Logic for Marketing. *Journal of Marketing,* 68, 1-17.

Wee, K.N., & Kek, Y.C. (2004). *Authentic Problem-Based Learning*. Rewriting Business Education. Singapore: Prentice Hall.

Wood, E. J. (2004). Problem-Based Learning: Exploiting Knowledge of how People Learn to Promote Effective Learning. *Bioscience Education,* 3. *http://bio.ltsn.ac.uk/journal/vol3/beej-3-5.htm*

A Problem-Based Learning Strategy in an Introductory Mechanical System Design Course

Witaya Wannasuphoprasit [a] *, Kuntinee Maneeratana [a]

[a]*Department of Mechanical Engineering, Faculty of Engineering Chulalongkorn University, Bangkok, 10330, Thailand*

Abstract

This paper described a model for the mechanical system design instruction that was adapted from the IDC Robocon events. Students attended short lectures and then divided into groups for the design, built and test of a drill-powered bicycle retrofit in a 3-weeks project. The process involved problem specification, conceptual designs and cardboard/wood real-scale prototypes before building the working products for testing. All process were peer discussed in class and a facebook page. The model was very successful for both the outcome and student's satisfaction. All groups were exposed to the first full-design circle and could achieve the objectives with increased creative thinking.

Keywords: Problem-based learning, mechanical design, IDC Robocon

1. Introduction

In a Thai University, a main problem during a mechanical engineering curriculum revision was to ensure the design-related and associate soft-skills outcomes. Being restricted by the demands of the professional authority in Thailand, the Council of Engineers, on course contents and Ministry of Education regulations on all curricula (Pimpin & Maneeratana, 2010), most of the possibly related and spared credits were channeled into the so-called design and experiment streams of connecting courses. Even with the new design stream, it was apparent that the changes were not enough; new instructional and learning approaches were sorely needed to cope with students who lacked the real-life, hand-on experiences and needed repeated exposure to design process from conception, design, manufacturing, operation, redesign and, if possible, creativity as well as entrepreneurship.

The descriptions of two related courses, 2103313 Mechanical System Design I and 2103314 Mechanical System Design II were 'Theories of Failure; fatigue design; design of machine elements: gear, shaft, screw, fastener, rolling element bearing, journal bearing, clutch and brake, belt, and chain.' and 'Introduction to design process: the specification development/planning phase; the conceptual design phase; concept generation, concept evaluation; product design phases, product generation, evaluation of function and performance, evaluation of cost, ease of assembly; finalizing the product design; design projects, covering assumption, calculation and design evaluation and presentation and with a complete report'. These courses were quite cumbersome and uninspiring even though they satisfied the requirement from the Council of Engineers.

During the transition from the old 2002 curriculum to the new one in 2011, it was decided that some old courses would be used as the pilot courses before the full implementation in the revised curriculum. Specifically, a design-centered course in the sixth semester of the program, 2103314 Mechanical System Design II, was selected. With 2-year leading time, the new instructional model could be deployed, accessed and refined twice. The key was not to change the overall contents but the instructions and learning had to be changed so that both contents and outcomes were satisfied.

The new instruction model was inspired by the International Design Contest, popularly known as the IDC Robocon. The first event was organized in 1990 by the Massachusetts Institute of Technology (MIT) and Tokyo Institute of Technology in Japan (Yamakita, 2009). The concept of the event was to bring engineering students from different countries together. Competing teams for specific objectives with limiting resources were formed by mixing students from various backgrounds so that the teamwork was emphasized (Getschko, 2009). Thailand joined the event in 2007 by hosting the event in Bangkok (Pipatpongsa *et al.*, 2008). To select students for this international event, the national event Robot Design Contests (RDC) had been jointly hosted by the National Metal and Materials Technology Center (MTEC) and the Faculty of Engineering, Chulalongkorn University (Rungfapaisarn, 2012). The first rounds of activity were organized at regional locations – Chiang Mai University in the northern, Prince of Songkla University in the southern, Suranaree University of Technology in the north-eastern. The national rounds were held at Chulalongkorn University with the final competition at a popular department store. The 4-week activities started with some theoretical and practical training before commencing with the specified tasks of robot design, building and testing.

The activities were so successful with very positive feedbacks from students and lecturers alike. At the Department of Mechanical Engineering, Chulalongkorn University, there were huge demands from students for the limit number of seats in the event. Hence, it was logical that the gained expertise would be incorporated into a design course for all students. For the implementation during the transition from the old to the new curriculum, the adapted instructional model was first piloted in the Academic Year 2010 with supporting expertise from a lecturer and a Ph.D. student of the Faculty of Education (Seechaliao *et al.*,

* Corresponding Author name. Tel.: +66-2-218-6610
E-mail address: witaya.w@chula.ac.th.

2011, 2012a & 2012b). The model was further refined for the course in 2011 before the formal implementation in a second year course in the academic year 2012.

It was the model and experience in 2011 that was described in this paper. As the previous articles focused on the development and validation of the generalized instruction model and assessing instruments, the course management was left out. In addition, the emphasis was on the working prototypes in 2010; in 2011, the instructional model was also further refined to add the construction and operation of the final prototypes. Hence, the objective of this paper was to describe in details the revised instructional model as well as how the course was actually conducted as a realistic example. In the following sections, the instructional model, course descriptions and selected case study as well as the actual conduction were described.

2. Instructional Model

This design course was a part of the educational research and development of the instructional design and development for engineering creative thinking (IDECT) model (Seechaliao *et al*., 2012a) which was implemented and evaluated across three engineering disciplines. This IDECT model of instructional strategy was a systematic step-by-step activity that could improve the instructional design skills of instructors in a more efficient manner (Seechaliao *et al*., 2012b). Six experts agreed that the instructional model was appropriate in good and excellent levels as the instructional models specifically included several features that promote creative thinking and product designs, including mind-mapping, brain-based learning process and constructivist via electronic portfolio, etc. In the evaluation of students' skills in the Academic Year 2010, post-test score for creative thinking was significantly higher than the pre-test score at the 0.05 significant levels. The post-test score for creative product was at fairly good level (Seechaliao *et al*., 2011).

The design instructional approach required repeated sets of 'think' and 'do' as shown. When compared to the previous year (Seechaliao *et al*., 2011), the cycle contained the third 'think' and 'do' sets for the final prototypes (Figure 1) in addition to the first sets for the conceptual design and second sets for the quick prototypes. By adapting the instruction model based on engineering creative principles for developing creative thinking skills (Seechaliao *et al*., 2011) by adding the last set, the revised instructional process was shown in Figure 2.

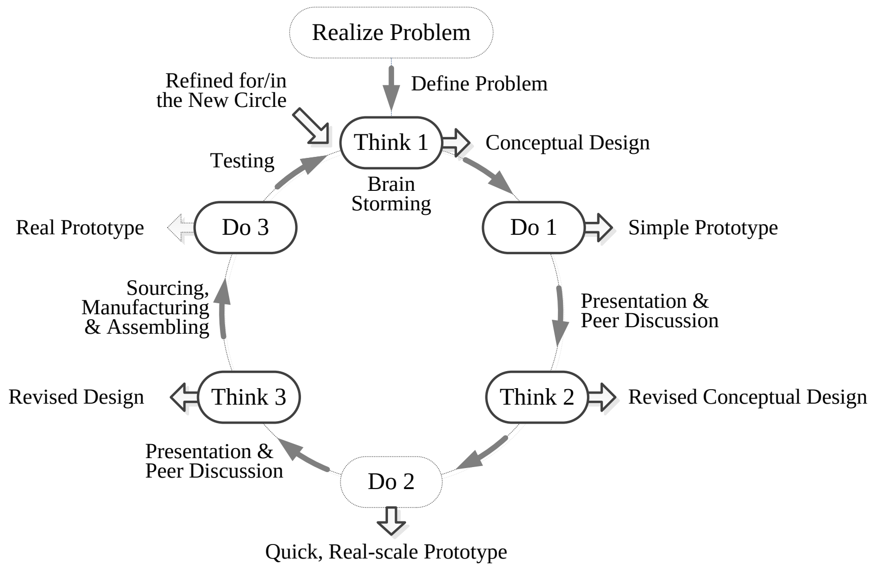

Figure 1. Design approach model

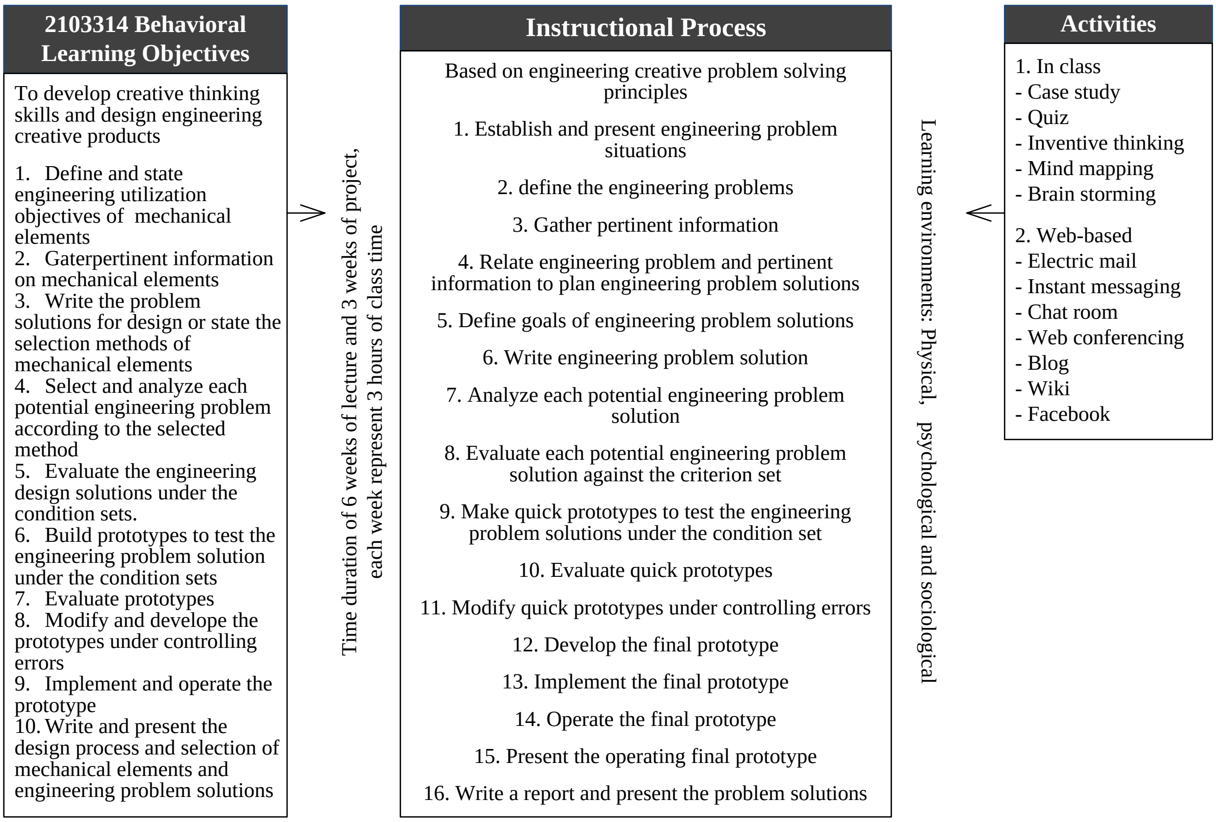

Figure 2. Part of the instructional model based on engineering creative problem solving principles, modified from Seechaliao *et al*. (2011)

3. Course and Case Study

During the transition to the new curriculum, the course conduction was split into two parts (Table 1). The first part involved traditional lectures and quizzes. Then, the class of 75 students was split into 3 groups which would attempt 3 three-week projects in parallel. One of these projects was chosen for the new instructional model.

Table 1. Course Structure

Week	Activity		
	Group I	Group II	Group III
1-6	Theory (Lectures and Quiz)		
7-9	Project a	Project c	Project b
10-12	Project b	Project a	Project c
13-15	Project c	Project b	Project a

The design cycle was imparted to students in a step-by-step approach (Table 2) in only 3 weeks. The students were cycled through the cooperative learning process for problem defining, product requirement, product specification, conceptual design, simple prototypes, revised conceptual design, quick cardboard and wood prototype, final design, final prototypes and testing such that each groups had to present their works and progress to others for discussion and approval.

Table 2. Step-by-Step Activity and Outputs

Process	Activity	Output
Problem statement	Group work/brainstorming	Defining problem
Design requirement	Group work/brainstorming	Design Requirements
Review of information	Information research	Existing products, patents, related standards, user interfaces, ergonomics, and other information needed in the design calculation for products and users
Conceptual design	Group work/brainstorming	Poster and presentation to other groups for discussion, vote and approval
Revised conceptual design	Group work	Specification for quick prototype
Quick prototype	Cardboard/wood building	Real-scale model with the bicycles/sketchboards and presentation to other groups for discussion, vote and approval
Final design	Group work/engineering sizing, component selections	Detailed design with analyzed load and detailed specification and calculation for components and parts
Working prototype	Manufacturing, purchasing, assembling & tinkering	Final products for testing
Presentation	Testing rounds	A4 brochure and reports (with CD for reports, references and activity VDO)

Different new case studies that increased the students' awareness on the societal and environmental impact and responsibility were selected each semester. For the first run in 2010, the soda can crushers were designed (Seechaliao *et al.*, 2011). For the second time in the academic year 2011, the drill-powered bicycle/handle skateboards retrofits were used as the case study. The origin of this project topic came from the BOSCH Thailand Cordless Racing 2011, the national qualifying round for the Power Tools Asia Cordless Race 2011, in which the company invited vocational and engineering students to participate in the competition to celebrate the 125th Anniversary (Bosch Thailand, 2011). The company presented teams that passed the first round with 4 cordless BOSCH GSB-18-1-li drills. A team of second-year students from the Department of Mechanical Engineering participated in the competition and came back wondering that they ought to be able to perform better. They, thus, consulted lecturers and suggested the project topic which led to the drill-powered bicycle retrofit by converting a regular bicycle or skateboard to electric bicycle. However, the problem was of a smaller scale with only one drill as the power source with strong emphasis on the learning experiences.

4. Couse Conduction

As described in Figure 1 and Table 2, students started working in assigned groups with brainstorming on the problem statement and design requirement, followed by information search and gathering on the existing products and related information for needs, requirements and inspiration. They, then, produced conceptual designs (Figure 3) to fit their selection platforms, bicycles or handle skateboards which were presented to other groups for peer discussions and voting for the best options in class under the lecturer's observation and supervision. The works and the amount of efforts required to complete the projects required the approval from other groups in the mutual agreements. Then, the conceptual designs were revised and presented to the class for discussion again. Some quick 'dirty' real-scale prototypes, made from cardboards, wood, ropes and similarly simple components, were used to demonstrate the working of the system.

Figure 3. Examples of product statements and preliminary designs

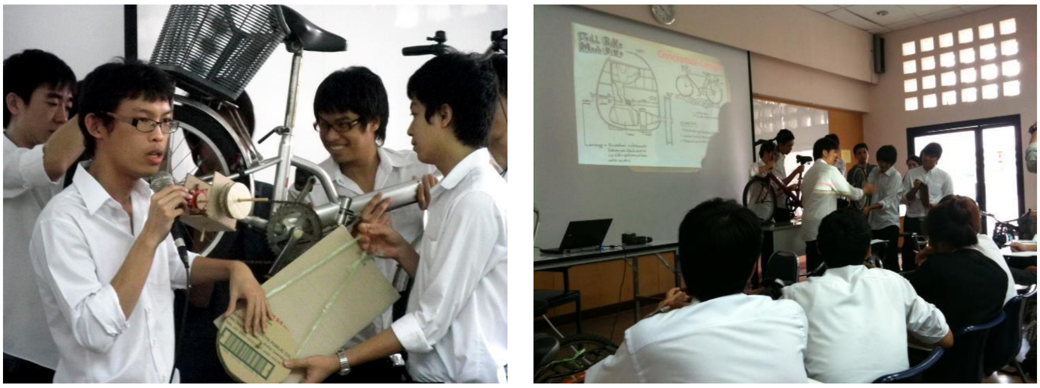

Figure 4. Presentation of quick, real-scale prototypes

For the final designs, students had to provide the full analyses, components and other details before embarking on building of the working prototypes. The additional resources and cost were minimal. Old bicycles and handle skateboards that belonged to students were used. Standard components, be new or second-hand, were searched for and procured from local shops by students themselves. The average spending per group was only 1,000 Bahts (roughly 33 USD) with the maximum of 1,500 Bahts (about 50 USD). For non-standard parts, students manufactured them themselves in the Departmental machine shops of which the upkeep and safety training was a standing cost in the Department. These activities were crucial to students with few or non-existent hand-on experiences in engineering tools.

All the time, students reported the progress and discussed the experiences and results with lecturers and peers in class, face-to-face and, more frequently, facebook. Figure 5 was an example of the second update on a working prototype. Students aligned the driven wheel to the bicycle rear wheel and secure the driven wheel frame to the bicycle frame. The lecturer posted comments on the compressive force and related friction as well as recommending some testing for which students posted the testing VDO clips with descriptions of encountered problems, correcting actions, good points and proposed further improvements. This communication was not only a part of the recorded portfolio, it also provided cooperative learning atmosphere and peer pressure on the other groups.

Figure 5. Online discussions on a prototype

Even though the schedule was very tight, students usually finished the working prototypes quite ahead of the deadlines and had much fun riding the final products and posting the VDO clips in facebook. Some groups had enough time to improvise additional improvements. The formal testing rounds, prototype presentation and actual runs, were held during lunch breaks at the main Faculty-wide students' activity space adjacent the canteen and in full view of all faculty and students who were invited to observe and comment on the prototypes (Figure 6). Obviously, students were very proud of their works and showed increased confidence in the ability to be creative and succeed. Some students even expressed further interested in similar works or competitions.

The whole process, discussions and results were also recorded and shared to other students in the same class as they studied the other parallel projects. Thus the first loop in the 3-week design cycles (Figure 1) was completed. The first set of students went on to other projects but still kept in touch with the progress via personal contact and facebook. The second set of students (Table 1), who just completed another project, started the design cycle again. However, they had the choice of either doing the whole new design or taking over the first retrofits and refining the old design. Due to the short period involved, they inevitably chose the refining path. It was noted that the required works for refining involved no less effort than the first design as students had to modify and add extra mechanism that boosted the performances, users' safety, comfort and maintenance, etc., under a higher level of constraints.

Figure 6. Some of the testing rounds

5. Conclusions

This instructional model was based on repeated ‘think’ and ‘do’ process for the conceptual design, quick real-scale prototype, and final working prototypes in the cooperative learning setting. Throughout, the ideas and works in each group were shared, discussed and approved by peers while the lecturer provided technical advices and expertise. Even the percentage of the awarded scores for the project were quite low as it was just a small part of the course, students were very enthusiastic and eagerly embarked on the challenge.

This problem-based learning strategy for a mechanical system design course was found to be very successful and cost effective, both in terms of learning efficiency and resources as well as much increased motivation, enthusiasm and satisfaction of students who expressed much appreciation, confidence and pride in their works. In the 2011 revised curriculum, this model was pushed forward to the third semester of the study. This was the earliest possible time that the Department took full responsibility of the students after they selected the discipline at the end of the first year.

In many ways, this course addressed many issues that in many engineering schools implements for new students during the first year (Ambrose & Amon, 1997). This push forwards was expected to relieve the major problems of few full-circled design and manufacturing experiences. This situation exerted some limitation on the scope for the senior projects due to the need to ensure that students were repeatedly exposed to complete design cycles (Sripakagorn & Maneeratana). Preliminary results for the first semester of the academic year 2012 were even better, judging from the products and reflective journals. The medium term strategy included the refinement of the model as the first spearhead into the adoption of the CDIO concept (Crawley *et al.*, 2007). The cooperation and integration with other courses, particularly the related one in the same semester for parallel and integral experiences would reduce the total workloads of students and demonstrate the importance and real-life application of the basic engineering theory (Maneeratana *et al.*, 2012).

Acknowledgements

The development of this course was possible with helps from Dr. Thapanee Seechaliao and Assoc. Prof. Dr. Onjaree Natakuatoong of the Faculty of Education, Chulalongkorn University as well as the continuing supports of the Faculty of Engineering, Chulalongkorn Unversity for the RDC contests. The BOSCH (Thailand), Co., Ltd. was thanked for the inspiration of the case study.

References

Ambrose, S. A. & Amon, C. H. (1997). Systematic design of a first-year mechanical engineering course at Carnegie Mellon University. *Journal of Engineering Education*. 86(2), 173-181.

Bosch Thailand. (2011). *Power Tools Asia Cordless Race 2011*. Online company publicity, 22 September 2011. Available at http://www.bosch.co.th/content/language2/html/index_7031.htm.

Crawley, E., Malmqvist, J., Östlund, S. and Brodeur, D. (2007). *Rethinking engineering education: the CDIO approach*. Springer.

Getschko, N. (2009). The use of design contests to increase the student’s motivation. *International Conference of Engineering Education and Research (ICEE & iCEER 2009)*. Korea.

Maneeratana, K. & Sripakagorn, A. (2010). Key subject indicators and admission impact from subject grades in mechanical engineering-based bachelor programs at Chulalongkorn University. *2010 ASEE Annual Conference and Exposition*. AC 2010-1187, Louisville, USA.

Maneeratana, K., Paphapote, T., Singhanart, T., Noomwongs, N. and Luengruengrit, S. (2012). A problem formulation project in Statics for connecting the theory to daily application. *Procedia - Social and Behavioral Sciences*. 56, 258-264.

Pimpin, A. & Maneeratana, K. (2010). Revision of the mechanical engineering curriculum at Chulalongkorn University under new regulations and quality assurance. *2010 ASEE Annual Conference and Exposition*. AC 2010-1225, Louisville, USA.

Pipatpongsa, T., Moriizumi, T., Kitahara, T. Shimura, T. Kunieda, H. & Nishihara, A. (2008). Educational drive of Tokyo Tech towards human resource development in Thailand. *1st Thailand-Japan International Academic Conference*. 175-176.

Rungfapaisarn, K. (2012). Student contest to enhance robotic design talent with eye on AEC. *The Nation Newspaper*. 27 April 2012. Available at http://www.nationmultimedia.com/business/Student-contest-to-enhance-robotic-design-talent-w-30180791.html.

Seechaliao, T., Natakuatoong, O. & Wannasuphoprasit, W. (2011). The instructional model based on engineering creative problem solving principles to develop creative thinking skills of undergraduate engineering students. *European Journal of Social Sciences*. 26(3), 408-420.

Seechaliao, T., Natakuatoong, O. & Wannasuphoprasit, W. (2012a). The validation of an instructional design and development model based on engineering creative problem solving principles to develop creative thinking skills of undergraduate engineering students. *International Proceedings of Economics Development and Research*. 30, 92-100.

Seechaliao, T., Natakuatoong, O. and Wannasuphoprasit, W. (2012b). Instructional design and development activities to develop creative thinking skills of undergraduate engineering students. *International Journal of Innovation, Management and Technology*. 3(2), 101-105.

Sripakagorn, A. & Maneeratana, K. (2010). Design as the priority for engineering education: An implementation in a senior project course, *2010 ASEE Annual Conference and Exposition*. AC 2010-1181, Louisville, USA.

Yamakita, M. (2009). Engineering design education via IDC robot contest. *IFAC Proceedings Volumes*. 8(1), 227-232.

Engineering for Employability: A transition into CDIO

Robin Clark[a], Jane Andrews[a],

[a]*Engineering Education Research Group, Aston University, Birmingham. B4 7ET. UK*

Abstract

This paper draws upon the findings of a three year study which tracks an institutions journey of CDIO. In focusing on the student perspective the findings discuss students' prior learning experiences and their expectations of university. The study considers students' early perceptions of CDIO; emergent findings suggest that whilst CDIO is not really what students expect when they first arrive at university, most prefer it to 'traditional lectures'. Indeed the majority indicate that they believe the approach enhances their employability and provides a more engaging learning experience. The conclusion argues that with its focus on problem-based learning and team-working, CDIO has changed the face of the 1st year experience for mechanical engineering and designed students within the university and that in doing so it has enhanced transition and ultimately promoted student success.

Keywords: Problem Based Learning, CDIO, Active Learning, Employability.

1. Introduction

This aim of this paper is to provide a brief introduction into the emergent findings of a longitudinal engineering education research project the purpose of which is to map, critique and evaluate the introduction and subsequent development of a problem-based learning approach in a UK School of Engineering and Applied Science. Focusing specifically on CDIO the study has followed the introduction of CDIO in the School right from the onset, looking closely at student expectations and experiences. Bringing together three years' data this paper discusses students' perspectives of their first term in university, whereupon they suddenly find themselves immersed in a completely 'alien' learning approach – that of CDIO. Perhaps the most important finding of the study is that from the students' perspectives, one of the main benefits of problem-based learning is that it is built upon an ethos of 'real-life' learning. By being given the opportunity to work on 'real' problems CDIO quickly engenders a sense of identity, enabling first year students to begin to 'feel like engineers' right from the onset. In doing so it promotes a sense of loyalty and pride in the discipline across the cohort.

2. Background & Context

The requirement for undergraduate engineering education to provide industry with 'work-ready' engineering graduates able to 'hit the ground running', in possession of the necessary high level practical skills and theoretical knowledge required by an exceptionally diverse sector (Lucena et al, 2008), means that engineering programmes find themselves facing unprecedented pedagogical challenges. Contextualised by the wider economic situation in which higher education finds itself having to 'cut-back' financially, such challenges mean that engineering schools need to provide a curriculum that balances academic and theoretical rigour with the practical training demanded by industry. The question of how to do this within a limited budget is one that many engineering schools are facing, and one that is further complicated by widely held stereotypical beliefs that as a profession engineering is dominated by inequalities in gender, social class, and ethnicity (Gill et al, 2008; RAEng, 2010). The image and reputation of 'degree-level' engineering as being suitable for white, middleclass, males only is reflected difficulties experienced by many engineering schools in attracting suitably qualified young people onto undergraduate engineering programmes; an issue which in itself is further compounded by problems with student attrition as many students enroll onto engineering programmes only to 'drop-out' during the first year (DIUS, 2008; RAEng 2008).

Whilst many engineering schools struggle to attract, and then keep, young people onto undergraduate programmes, warnings that unless quickly matters improve then the UK will face unprecedented shortages of engineers in the near future (Spinks et. el, 2006) means that something needs to be done urgently. Indeed, without action there is the danger that, in the UK at least, engineering education may soon find itself struggling to survive. This makes the need to both look at the curriculum and at how engineering programmes can 'make employable graduates' of vital importance.

Set against this background, in 2010, colleagues at Aston University took the decision to dramatically alter the undergraduate syllabus in Mechanical Engineering and Product Design by introducing problem-based learning in the form of CDIO across the first year curriculum (for further details see CDIO, 2013; Crawley, 2002). The main reasons for introducing such a major change reflected a desire by academic colleagues and managers alike to provide an academically relevant and industrially attractive curriculum that would provide students with high level work-ready skills whilst making sure they continued to learn the relevant empirical underpinning of the discipline. Concurrently with the introduction of CDIO, engineering education researchers were employed to track and record the experiences of both staff and students as the changes were put into place and 'rolled out'.

3. Methodological Approach

Starting with the research question "How effective is CDIO as a learning and teaching approach in Mechanical Engineering and Design Education?" an Action Research Design based upon a mixed methodological approach was put into place to enable the researchers to follow the programme development and delivery right from the onset. Whilst the researchers have utilised a number of different tools in the course of the study including semi-structured interviews, overt non-participatory observations, focus groups and surveys, this paper draws upon the quantitative part of the study only.

In drawing upon three years survey findings, the paper considers the issues around students' transition into university. Using 5-point Likert (Agreement) scales to collate and analyse data regarding students' previous learning experiences, their expectations of study at university, and their perceptions of CDIO at the end of the first term in their first year of study the paper provides a unique insight into some of the issues impacting students' experiences.

The response rate over the three year period varied from 42% in year one, to 51% in year two and 43% in year 3. The gender split of the three year period was 18% females and 82% males. Around 60% of each cohort was from a BME (Black and Minority Ethnic) background. On average 15% of each cohort were international students (non-EU).

4. Findings

The first part of the survey examined students' previous experiences using different learning approaches. This was particularly important as in redeveloping the curriculum colleagues had identified a need to gain some understanding of students' ontological and epistemological 'starting points'. Put simply, the differences in learning approaches and styles between high school and university means that it is important for academic colleagues understand where students are "coming from" when developing the new problem-based curriculum. This enabled the curriculum to be adapted in such a way so as to maximise student learning.

Looking at the collated data, the most frequently experienced approach was 'problem solving' with 'project work' and 'making things' also proving popular. The approach to which the least amount of students had been exposed was 'worksheets'. Figure 1 below shows the percentage of students in each cohort who indicated that they had experienced the different types of approaches.

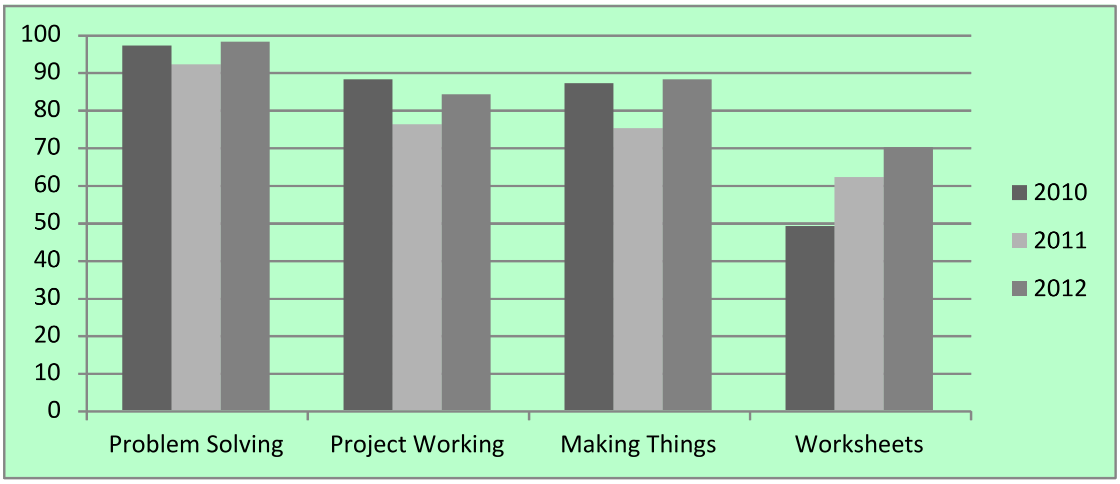

Figure 1: Percentage of students in each cohort who agreed they enjoyed each learning approach (Per Cohort)

In addition to looking at the students' experiences with regards to learning approaches, the survey also considered the students' previous learning environments. Across all three years the most commonly identified learning environment was that of working in groups with 80% of the students indicating they had some experience of group-work. The least experienced learning environment comprised classes of 20+ which was experienced by 26% of the overall sample. Figure 2 below shows the aggregated data relating to the students' exposure to different learning environments.

Figure 2: Students' previous exposure to different learning environments

The next set of questions focused on students' expectations of how they would learn in university. Figure 3 below shows that the majority of the sample expected to be working in teams and to be involved in 'experiments' and 'model making'. Whilst just under two-thirds expected to find themselves required to 'read' as part of learning at university; additionally, less than a third expected to be involved in role-play and only a quarter thought they would be required to write essays.

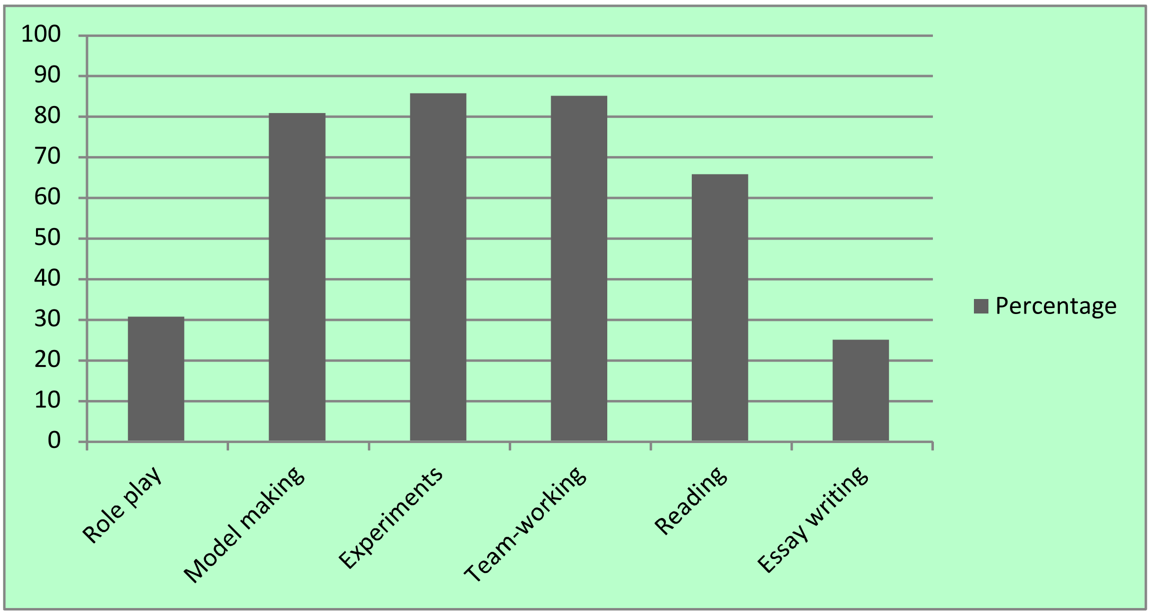

Figure 3: Students' expectations of how they would learn at university

The next part of the survey examined the students' perceptions of their first term at university learning using the CDIO approach. This data is displayed disaggregated across the three years to give some indication of the students' changing perceptions year-by-year as the concept of CDIO developed and changed within the university.

In addition to considering students affective perceptions of CDIO the survey also sought to gain some insight into how they perceived CDIO would equip them with transferable skills and in doing so promote their employability. Again this data has been disaggregated to give some indication of the students changing perceptions year-by-year.

5. Discussion

The data presented in this paper effectively 'tracks' the first three years of CDIO at Aston University. The first two charts examine students' previous learning experiences. The demographic nature of the student body at Aston is such that there are high numbers of non-traditional students with the majority being of a BME background (57%) and from a *working-class* background. The majority of first year students are 18-20 years old and have studied A levels or BTEC prior to university – although in engineering a significant minority are accepted following successful completion of a Foundation Year. Around half of the students are 'local', living at home whilst studying. Figure 1 reveals that a significant majority of all three cohorts had participated in problem-solving, project working and making things in the two years before attending university; with the use of worksheets being the least experienced. The emphasis on 'practical hands-on' learning is perhaps not surprising given that the sample comprised engineering and design students all of whom had studied the prerequisite subjects for each discipline. When considering the data in Figure 1 alongside Figure 3, that the students least expected to find themselves writing essays is perhaps not entirely unexpected and again reflects the practical approach of the courses the students had previously studied and were indeed studying at university. Conversely, although the majority of students had experienced working in groups before university (Figure 2) and had enjoyed participating in practical learning approaches (Figure 1), the data suggests that they did not necessarily believe that CDIO represented an 'ideal learning approach'. Indeed, data in Figure 4 reveals that in 2011 and 2012 less than half of the students indicated that it was their preferred learning approach.

In considering why this might be the case, and in looking at why the students' perceptions of CDIO altered year on year (as shown in Figures 4 and 5) it is important to take into account the wider context. CDIO at Aston was introduced in 2010 with a very limited budget. However, what the programme lacked in financial backing was more than made up for by the enthusiasm and motivation of the teaching team – all of whom were, and still are, dedicated to the approach and determined to make it work. In the first year, the materials and problems were locally sourced, with the emphasis not only being on problem-solving but also encapsulating innovative thinking and resourcefulness. The cohort in this year could not help but be caught up in the 'excitement' of being part of something new. In year two the teaching team changed slightly, with the previous first year teachers moving onto facilitate learning at level five and the first year being taken by a senior researcher and less experienced newly qualified colleague. Concurrently there was a slight dip in students' affective perceptions of CDIO in terms of engagement and enjoyment, as well as how they perceived it to promote different aspects of employability. In 2012 the students' perceptions changed again with a significant majority indicating that they found CDIO an engaging and more enjoyable learning approach than lectures. Likewise the percentage of students indicating that they believed that CDIO promotes the various aspects of employability also rose in 2012 with improved problem-solving skills, team-working and linking theory to practice being identified as part of CDIO by over 80% of the cohort. This upturn in students' perceptions corresponds with another change in the teaching team, with the original team from 2010 having much more input.

The influence of the teaching team on students' perceptions is not entirely unexpected – as is the fact that the majority of students selecting to come to Aston indicated that during their A levels or previous studies they had enjoyed problem-solving, working on projects and making things. Additionally as CDIO has developed in the university more resources have been dedicated to it – with materials now purchased in 'kit form' to give a more professional grounding.

6. Conclusion

The data given in this paper represents the first three years of what is anticipated will be a longitudinal study. CDIO was launched in 2010 with the intention of providing an approach that both enhanced the student experience and provided industry with work-ready graduates able to 'hit the ground running'. The first cohort of students to have experienced CDIO from the first year of their studies as yet to graduate yet early indications are that this cohort are not only more prepared for work but actually want to enter the discipline when they graduate.

This study is unique in that it has tracked the introduction of CDIO right from the onset. The slight 'dip' in students' perceptions in the second year of the approach is indicative of the expected 'teething problems'. Despite financial restrictions and some cynicism from colleagues, the CDIO teaching team continue to work hard to make a success of the programme. There can be little argument that three years on that this determination is beginning to pay dividends for the students who anecdotally state that CDIO enables them to 'feel' like engineers right from the time they start university. With its focus on problem-based learning and team-working, CDIO has changed the face of the 1st year experience for mechanical engineering and designed students in doing so it has enhanced transition and ultimately promoted student success.

In conclusion, this study is beginning to show that one of the main benefits of problem-based learning in general and CDIO in particular is that in based upon a 'real-life' approach to pedagogy it engenders a sense of identity amongst the students. This sense of identity quickly manifests itself in students who begin to 'feel like engineers' right from the beginning of their university careers. At this stage it is difficult to envisage what the long term outcome of this may be, however, in observing the students a sense of 'pride' in their achievements is evident.

References

CDIO., (2013). *CDIO.* http://www.cdio.org/ Accessed April 27th 2013.

Crawley, E.F., (2002). *Creating the CDIO Syllabus: A University Template for Engineering Education.* ASEE/ IEEE Frontiers in Engineering Conference Findings. November. Boston

DIUS. (2008), *A Vision for Science and Society*, London, The Royal Academy of Engineering, Department of Innovation, Universities & Science.

Gill, J., Sharp, R., Mills, J., & Franzway, S., (2008). 'I Still Wanna be an Engineer! Women, Education and the Engineering Profession', *European Journal of Engineering Education.* 33. 4. pp 391-402.

Lucena, J., Downey, G., Jesiek, B., Elber, S. (2008). 'Competencies Beyond Countries: The Reorganization of Engineering Education in the United States, Europe and Latin America'. *Journal of Engineering Education.* 97. 4. pp 433-447

RAEng. (2008). *Engineering.* House of Commons Committee on Innovation, Universities, Science and Skills. London. Royal Academy of Engineering.

RAEng. (2010). *Engineering the Future: A Vision for the Future of UK Engineering.* London. Royal Academy of Engineering.

Spinks, N., Silburn, N. & Birchall, D. (2006). *Educating Engineers for the 21st Century: The Industrial View.* London: Royal Academy of Engineers.

The Implementation of Problem Based Learning (PBL) by using FILA Form in Measuring Student's Life Long Learning

Ruqayyah Ismail [a] *, Nor Hafizah Hanis Abdullah [b], Fariz Aswan Ahmad Zakwan [c] , Badrul Nizam Ismail [d], Wan Noorli Razali [e]

[a]*Faculty of Civil Engineering, Universiti Teknologi MARA, Cawangan Pulau Pinang, 13500 Permatang Pauh, Pulau Pinang,Malaysia*
[b]*Faculty of Civil Engineering, Universiti Teknologi MARA, Cawangan Pulau Pinang, 13500 Permatang Pauh, Pulau Pinang,Malaysia*
[c]*Faculty of Civil Engineering, Universiti Teknologi MARA, Cawangan Pulau Pinang, 13500 Permatang Pauh, Pulau Pinang,Malaysia*
[d]*Faculty of Civil Engineering, Universiti Teknologi MARA, Cawangan Pulau Pinang, 13500 Permatang Pauh, Pulau Pinang,Malaysia*
[e]*Academy of Language Studies, Universiti Teknologi MARA, Cawangan Pulau Pinang, 13500 Permatang Pauh, Pulau Pinang,Malaysia*

Abstract

Recent education system has posed a big challenge to all educators in fostering intellectual development which primarily focuses on the resources available to students and lecturers using a more student centered learning approach. In an attempt to improve teaching and learning of a program, Faculty of Civil Engineering, Universiti Teknologi MARA has moved to a new paradigm with utmost enthusiasm and commitment. The implementation of Outcome-Based Education (OBE) system was proposed by the Malaysian Quality Assurance Department, Ministry of Higher Education to all Malaysian Universities since 2005. The Board of Engineers Malaysia, has shifted teaching and learning methodologies in the faculty to a more motivated and reformed education system in empirically assessing student's outcome. Since the end of 2007, the implementation OBE towards learning system in the faculty has created new dimensions in monitoring the students' development through the Program Outcome achievement. One of the difficulties found in its implementation is the measurement of the Program Outcome related to student's lifelong learning (affective domain). One of the courses of Diploma in Civil Engineering program, Structural Steelwork & Timber Design (ECS 328) for part 06 student has taken up this challenge to measure student's lifelong learning. Therefore, through a Mini project assessment students are given a PBL task with the implementation of FILA form to capture their lifelong learning skills.

Keywords: Problem Based Learning, lifelong learning, FILA form, Outcome Based Education.

1. Introduction

Today, engineering profession often deals with uncertainty and conflicting demands from clients, governments, environmental groups and the public. Technical competencies are very much needed by the newly graduated engineers, as well as skills in human relations so that they will be well accepted among the professionals. In addition, they must encounter the ambiguity of the real world that continuously changing, commercialization interest and legal issues which might be raised as consequences of every action taken.

With expansion of internet age, the engineering students require lifelong learning to be able to surmount their problems and direct their learning in accordance with the new problems faced in their daily life. They must also comprehend the nature of the workplace problem solving to be better prepared. Hence, a problem-based learning (PBL) approach is the capstone to capture all the needs of graduates for the workplace. PBL encircle around learning at philosophical model and practical level. The systematic philosophy makes PBL a suitable choice for a life- long learning process, because it provides a platform for learning through problem solving [8].

Problem-based learning emphasizes learning by doing, which provides a motivating context for learning. Students are given a real-world problem similar to those they would face as professionals. They grant ownership of the problem, and undertake the problem solving process. Meanwhile, instructors will take the role as their cognitive coach. A pedagogical goal of PBL is to help students develop their own problem-solving skills, rather than telling them how to solve the problem [1].

This approach creates a fundamental shift from a focus on teaching to a focus on learning and from convergent to divergent way of thinking. Students are given opportunity to enjoy the process of learning genuinely. The challenging part is to make changes that intrigue the students in making them motivated to learn with a need to understand and solve real managerial problems. At the same time, they will be independently, rationally and continuously learning to solve the problems.

2. Literature Review

Over 30 years, PBL approach has been used in multidiscipline. [6] defined PBL as an instructional and curricular learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem. He also suggested that current and future generations of students are vitally important to experience a problem-based learning approach and engage in constructive solution-seeking activities.

* Ruqayyah Ismail. Tel.: +6-04-382-3218
E-mail address: ruqayyah812@ppinang.uitm.edu.my

PBL mainly highlights its concepts to the students by means of challenges in the form of problems relevant to their future practice [3]. Instead of using a rigid lesson plan that directs a learner down a specific path of learning outcomes or objectives, project-based learning allows in-depth investigation of a topic worth learning more about. In addition, learners typically have more autonomy over what they learn, able to maintain interest and are motivated to take more responsibility for their learning [9].

In engineering programs, PBL approach has been reported by several authors, although the practice is still far from widespread. Georgia Institute of Technology has introduced 'Sustainable Urban Development' course, in which the students developed projects to make their campus and community more sustainable. In the process, students learn how to analyze sustainability, work with decision makers, and put classroom knowledge into practice. Further, through this course's emphasis was on problem-based learning within the curricula of civil and environmental engineering. This relates to a more general educational concern that the classroom often focuses on what information should students be told, rather than on how students can effectively learn and apply information [1].

While at McMaster University, the chemical engineers took the initiative to implement PBL in their program in the early 1980's. The program incorporates several student-centered teaching strategies and curriculum developments were integrated across its program, of which problem based learning is one of its components [2]. The same goes to Monash University, where the implementation of PBL into civil engineering program has allowed the groups of students to be able to identify their learning needs and find their learning resources [11].

3. Methodology

In this study, a course from Diploma in Civil Engineering program at the Faculty of Civil Engineering, Structural Steelwork and Timber Design (ECS328) was selected. Out of 7 Program Outcomes from this program, only 2 Program Outcomes measured through this course which are PO3: Ability to identify, formulate and solve engineering problems (Cognitive-C4) and PO7: Having the lifelong learning skills to search for information independently (Affective-A3). Through Mini Project assessment that is embedded in this course, Problem Based Education (PBL) assessment was designed and assigned to student with the implementation of FILA form. FILA form is form where **F** for **F**act, **I** for **I**dea, **L** for **L**earning Issues and **A** for **A**ction. This Mini Project is a one semester continuous task where students will complete it during their tutorial session every week and will be supervised closely by the lecturers. A complete design report with completed FILA form from every task is expected to be compiled at the end of the semester. Marks that students get from their filled FILA form will contribute directly to PO7 marks which will reflect their lifelong learning achievement.

A survey has been conducted to get students' feedback on the implementation of PBL in this course especially the significant use of FILA form and the lifelong learning skills measured through it.

4. Results and Discussion

There were 63 out of 84 students who took part in this survey and they were given only 4 questions that they have to rate either 1 (Not Agree), 2 (Partially Agree) and 3 (Agree). The survey also has given the students an opportunity to comment on the implementation of PBL in the course. From all comments received, it can be concluded that some students are unable to see the benefits of PBL and these students also perceived the implementation of FILA form as troublesome. The faculty has taken all these comments in and considers them for the continuous quality improvement of the course especially in designing more effective PBL task for students. Results obtained from the survey are as in the Figure 1, 2, 3and 4 below.

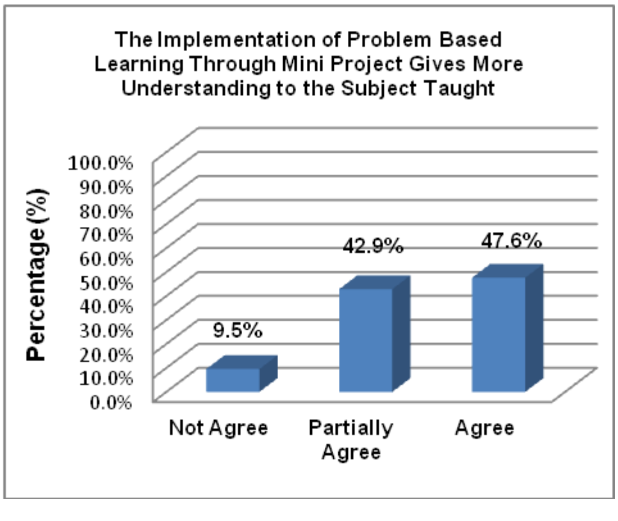

Figure 1. The implementation of problem based learning through mini project gives more understanding to the subject taught.

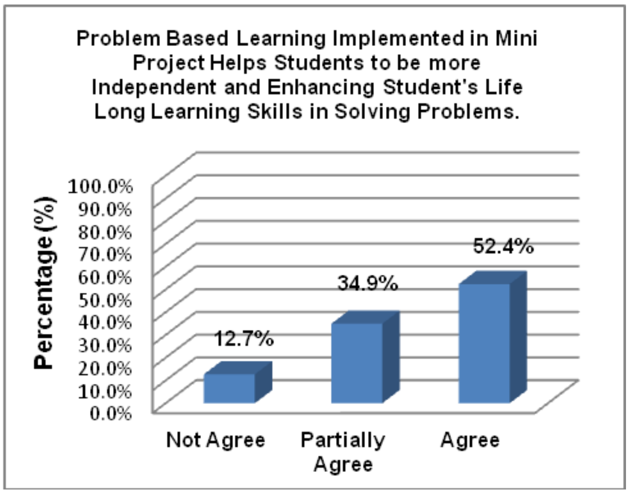

Figure 2. Problem based learning implemented in mini project helps students to be more independent and enhancing student's life long learning skills in solving problems.

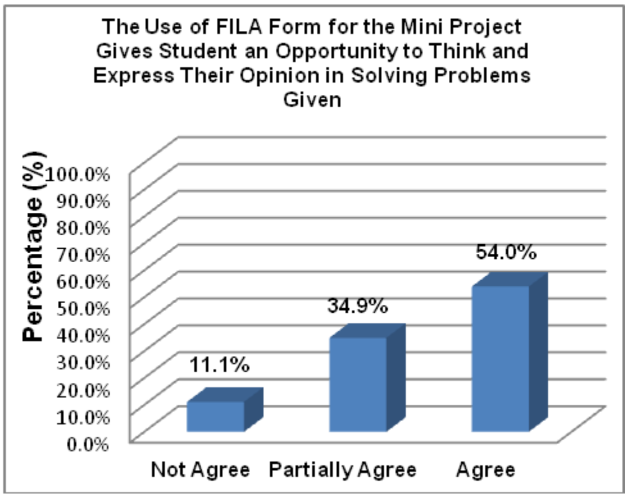

Figure 3. The use of FILA form for the mini project gives student an opportunity to think and express their opinion in solving problems given.

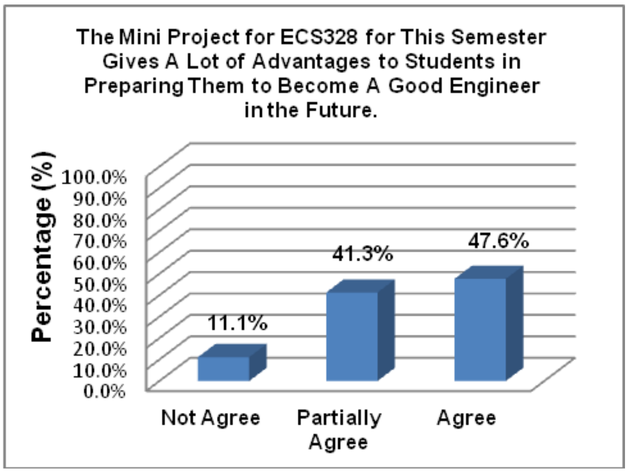

Figure 4. The mini project for ECS328 for this semester gives a lot of advantages to students in preparing them to become a good engineer in the future.

From the feedbacks obtained in Figure 1, there were about 47.6% students who agree that the implementation of problem based learning through mini project gives more understanding on the subject taught. Even though the number of students who partially agree was about 42.9%, the students are actually convinced that the method should be continued with some improvement. After all only a small percentage of 9.5% disagree on the implementation of PBL in the course.

Figure 2 shows a convincing feedback whereby 52.4% students agree that problem based learning implemented in mini project helps students to be more independent and enhancing student's lifelong learning skills in solving problems. This good feedback provides some evidences that student lifelong skills can be enhanced through PBL approach. Significantly, the feedback from students as referred to in Figure 3 where about 54% of the students agree on the given opportunity to think and express their opinion in solving problems through the use of FILA form for their mini project. This agreement has also convinced the faculty to continue its implement in the course.

5. Conclusion

1. PBL method with FILA form approach is proven to be a direct measurement which is practical to be conducted to measure student's lifelong learning.

2. The PO7 (lifelong learning) results can be used to continuously improve the assessment approach in assessing student's lifelong learning.

3. One of the weaknesses that can be discovered from this study is the lifelong learning assessment is measured collectively as group performance. To make the assessment's values more empirically genuine, individual measurement of student's lifelong learning should be conducted.

4. Students' feedback from the survey can be concluded as the following:

   a. Some students' partial preference on the use of the proposed method reflects their unwillingness to work on problem solving independently.

   b. Students find it a hassle to complete the FILA form because they are not used to the approach.

   c. The clarity in lecturer's instruction and the rubric of PBL's assessment need to be improved.

References

A. Steinemann, "Implementing sustainable development through problem-based learning: pedagogy and practice," Journal of Professional Issues in Engineering Education Practice, 2003, 129, pp. 216-224.

D. R. Woods, A. N. Hrymak, R. R. Marshall, P. E. Wood, C. M. Crowe, T. W. Hoffman, J. D. Wright, P. A. Taylor, K. A. Woodhouse and C. G. K. Bouchard, "Developing problem solving skills: The McMaster problem solving program," Journal of Engineering Education, 1997, 86, 2, pp. 75-91.

D. R. Woods, R. M. Felder, A. Rugarcia and J. E. Stice, "The future of engineering education III. Developing critical skills," Chemical Engineering Education, 2000, 34, 2, pp. 108- 117.

J. E. Mills and D. F. Treagust, "Engineering education – is problem based or project based learning the answer?" Australasian Journal of Engineering Education, online publication, 2003, 2003-04, http://www.aaee.com.au/journal/2003/mills_treagust03.pdf.

J. M. Brault, P. M. n M. Milan, M. Pico n-Nunez, M. El-Halwagi, J. Heitmann, J. Thibault, and P. Stuart, "Web based teaching of open-ended multidisciplinary engineering design problems," Education for Chemical Engineer, 2007, pp. 1–13.

J. R. Savery, "Overview of problem based learning: definitions and distinctions," Interdisciplinary Journal of Problem-based Learning, 2006, 1: Iss. 1, Article 3.

L. R. de C. Ribeiro and M. da G. N. Mizukami, "Student assessment of a problem-based learning experiment in civil engineering education," Journal of Professional Issues in Engineering Education And Practice, 2005, 131, pp. 13-18.

M. H. Bidokht and A. Assareh, A. "Life-long learners through problem-based and self directed learning," Procedia Computer Science, 2010, pp. 1446–1453.

M. M. Grant, "Getting a grip on project-based learning: Theory, cases and recommendations," Meridian: A Middle School Computer Technologies Journal, 2002, Issue 1.

O. Ates and A. Eryilmaz, "Factors affecting performance of tutors during problem-based learning implementations," Procedia Social and Behavioral Sciences, 2010, pp. 2325–2329.

R. Hadgraft, "Student reactions to a problem-based fourth year computing elective in civil engineering," European Journal of Engineering Education, 22, 1997, pp. 115-123.

S. A. Yost and D. R. Lane, "Implementing a Problem-Based Multi-Disciplinary Civil Engineering Design Capstone: Evolution, Assessment and Lessons Learned with Industry Partners," ASEE Southeast Section Conference, 2007.

Y. Wang, Y. Yu, H. Wiedmann, N. Xie, C. Xie, W. Jiang and Xiao Feng, "Project based learning in mechatronics education in close collaboration with industrial: methodologies, examples and experiences," Mechatronics, 2012, 22, pp. 862–869.

Discussion as media and tool in PBL project-groups: constructing learning and managing

Claus Monrad Spliid [a] *

[a]*UNESCO Chair in PBL in Engineering Education - Aalborg University, Vestre Havnepromenade 5, 1., DK-9000 Aalborg, Denmark*

Abstract

The Aalborg PBL Model encourages project-management as a way for students to achieve efficiency and effectiveness in their study-projects. This paper looks into how the development of conversation skills relates to project-management as well as other factors. Through analysis of interviews focusing on the discussions which groups undertake in their pursuit of problem-solutions fulfilling assessed real-world needs as well as meeting the requirements of the educational program, it is concluded that discussions serve as a media for achieving learning and as a tool for developing skills essential for professional engineering practice.

Keywords: PBL, process competences, project management, peer learning, discussion;

1. Introduction

We know that the Aalborg Model of PBL works – yet we don't know exactly why and how it works. Students go through up to 10 projects over 5 years, then they (usually) graduate and most are immediately employed in industry and being valued for their knowledge, skills and competences – not least skills and competences in handling collaborative projects. However, before acquiring an appropriate level of project-management competences, student-groups struggle with inadequate process efficiency and inadequate project effectiveness. Some of the causes of this (as perceived by students) can be detected through reading the process-analyses that groups report in connection with project reports for first and second semester. Apart from a general lack of similar project-collaboration experience (tools are provided through a course on PBL, Mosgaard & Spliid (2011)) the groups confess to inadequate management and unfinished or undecided *discussions* – by many students (although not all) labelled "idle time".

In extension to previous research into students' logic behind their project management (Spliid 2011), the objective of this research is twofold (1) find ways of facilitating students' handling of *discussions* in early semesters, and (2) find ways of motivating students for approaching *discussions* as a professional skill used by professional engineers. Henriksen (2011) reports how professional engineers (production-management and -design) engage in "coordination" activities during the implementation process – a process of "negotiating" with the implementing staff. As this management process was estimated by the engineers to constitute app. 50% of their time spend clearly there is a need for engineering students to prepare and qualify for this type of professional performance.

Students most often use the term *discussion*, however in this paper the term "conversation" will be used as a more neutral synonym when there is no direct reference to students' statements. Merriam-Webster (2013) describes conversation as originating from Latin with the meanings "to associate with" or "to turn around", while *discuss* means "to discourse about in order to reach conclusions or to convince", and "implies a sifting of possibilities especially by presenting considerations pro and con." Clearly there are other intentions embedded in students' use of *discussion* as any project group has many conversations concerning simple clarifications and verifications without attempting to *discuss* neither preconditions nor implications.

An illustration of the diagnostic potential embedded in group conversations can be made through a simple communication exercise called "Murder at the Black Horse": 28 pieces of information (relevant + irrelevant) distributed among 15-25 students; at least 2 observers; 5 simple questions – and the scene is set for an often predictable and sometimes dramatic conversation before the group (often reluctantly) offers its first guess attempting to answer the 5 questions (Who done it? When? Where? How? Why?). After an average of 45 minutes simulating the communication that dominates a semester long project a long list of "pitfalls and dangers" can be produced (see Table 1), and unfortunately only few examples of "best performance" can be extracted. Students' attempts to structure and manage the conversation systematically are hampered by personal issues (role preferences; emotions; lack of trust, competitiveness etc.) as well as lack of professional competences – thus unveiling the "monster" threatening students and groups which do not handle conversations with the necessary rigor.

* Corresponding: Claus Monrad Spliid. Tel.: +45-9940-2564
E-mail address: clauss@plan.aau.dk

Table 1. Group conversations: “Pitfalls and dangers” and “Best performance”

Pitfalls and dangers	Best performance
Hair-splitting/Quarrels	Organizing the process
Parallel conversations	Formulating helpful questions
Repeated conversations	Focusing on evidence/facts
Perfection/Fear of failure	Involving participants
Complexity/Ambiguity	Structuring information
Lacking insight/expertise	Summing up information
Speculation/Opinions	Evaluating process
Implicit assumptions	
Uncertainty/Doubt	
Uncritical/Overly critical	
Anarchy/Fragmentation	
Mistrust/Opposition	
Indecisiveness	
Ignoring evaluative info from observers	

The scope of this paper is to explore further into the groups’ process of acquiring and constructing the knowledge, skills and competences required for handling complex projects – specifically regarding the groups’ handling of conversations aimed at securing a sound progression with the process as well as the project. The aim is to gain a deeper understanding of the groups’ own perceptions of handling the conversations paving the road to project success. The initial research-question was:

“Which factors do the groups identify as significant for their discussions?”

Answering this question should provide evidence of groups’ own perception of significant factors – factors which influence outcomes related to intra-group relations, factual learning, competence achievement and resource management. These outcomes are perceived by supervisors to play an important role in achieving success whether it is success for the students or success for the Aalborg Model of PBL.

2. Conceptual framework

In order to create an overview of students’ perceptions of the circumstances surrounding their *discussions* an analytical tool was needed to distinguish among the approaches applied by the students, and for understanding the reasoning behind students’ efforts. The analytical tool should assist in providing a clearer picture of factors underpinning best performance as well as poor performance.

Spliid (2011) bases his categorization on the project-management logic emerging during the text analysis and he sets up a two-dimensional matrix. The managerial categories (vertical dimension) “goals”, “activities”, “tools” and “personal issues” seem valid and useful also for this analysis as they correspond with students’ writings and therefore correspond with their reasoning. The assumed group project-goals (horizontal dimension) “structure”, “efficiency”, “learning” and “familiarity” are however found less precise and less useful for this analysis as they originally emerged during a search for factors significant for an efficient and effective project overall. Therefore, in order to perform an in-depth analysis of the data generated from students’ statements, a second dimension must be added allowing a possibly unequivocal distinction between learning-related factors and management-related factors.

Barrett & Moore (2011) presents three interdependent principles derived from research into PBL-tutoring of study-groups (being part of a Diploma in Teaching and Learning in Higher Education), principles proposed as facilitators of the dialogic knowing which essentially is central for any PBL- and project-group:

- democratic social relations;
- co-constructing knowledge through co-elaboration;
- shared control.

Barrett & Moore (2011) thus relates their categorization to the learning process to be secured by the tutor in collaboration with the group – a situation distinctively different from the Aalborg Model.

Dixon (1999) has added the organizational dimension to Kolb’s learning-cycle which allows for an analysis based on a theoretical framework of cognitive abilities within the student-groups. The associated competences focus on “knowledge acquisition”, “knowledge integration”, “knowledge interpretation” and “knowledge implementation” – all of which are well known challenges for first-year engineering students. However, the management perspective does not appear explicitly out of this model.

While the “coordination” and “negotiations” carried out by the professional engineers (Henriksen, 2011) were rooted in knowledge implementation alone, student-groups’ conversations are assumed to cover the full learning-circle – although further analysis may bring evidence of any predominance. An assumption is that students do not distinguish among Dixon’s cognitive abilities, but rather focus on usefulness and usability in pursuit of completing the project (e.g. solving the problem – the typical focus of an engineer).

In light of the present focus on the communicative processes only, and assuming the principles proposed by Barrett & Moore (2011) will not provide a completely adequate picture of engineering students’ attempted accomplishments, a complimentary set of concepts for the horizontal dimension is therefore sought, leading to the following research question:

“What are purposes and contents of the group-discussions?”

Answering this question should provide evidence of groups’ own perception of the nature of the *discussions* taking place in the groups within the scope of the project. Extracting such “nature” should reveal insight into attitudes and circumstances essentially underpinning academic success for an engineering project-group within the Aalborg Model of PBL.

3. Methodology

The initial research was based on reading process-analyses from 1st and 2nd semester groups. The 2nd semester groups (Global Business Engineering spring 2011, 7 groups) had reported group as well as individual reflections, while the 1st semester groups (Energy Technology fall 2012, 10 groups) solely reported group reflections. Although the paramount intention for engineering students is producing a solution (practical or procedural) to a project-problem, the *discussions* in focus appear at any stage of the process, and in the process-analyses they are issues dealt with as part of project-management, group-collaboration as well as learning process – meaning that these *discussions* have a life of their own as project-constituents with a major impact on process and product.

To answer this question, semi-structured interviews of app. one hour were performed with two 4th semester groups, one 6th semester group and one 8th semester group (all studying Global Business Engineering). Developing these interviews as an open conversation (initiated by the questions “What do you do when you *discuss*?” and “Can you give me an example of a recent *discussion* you had?”) while simultaneously documenting students’ statements in writing on the black-boards in the group-room, the conceptual frameworks of Barrett & Moore (2011) and Dixon (1999) were presented in relation to issues emerging as the interview progressed. Also Henriksen’s (2011) findings from industry were presented as a reference to the professional practice the students are aiming for. At the end of the interviews the blackboards were photographed as documentation and support for the following analysis. Immediately after each interview an analysis was performed in order to maintain the evidence collected.

The interviews were employed as a means to clarify and verify the data obtained through the process-analyses as well as a means to identify skills and competences acquired during the extended project-experience. As the author has acted as lecturer and/or project-facilitator to all groups (during their first two semesters) it was possible to refer to the intended learning outcomes of these semesters – learning outcomes specifically dealing with process-competences related to project-management, group-collaboration as well as learning process.

During the interview students addressed just as much one another as the interviewer, and in-between they questioned the interviewer about the terminology used as well as the context, the background and the practical implications – exemplifying the acquired process-skills and –competences.

4. Analysis

4.1 Analysis of process-analyses

Making use of the principles proposed by Barrett & Moore (2011) provides an overview of the factors identified – see table 2. Despite the intention to perform an unequivocal distinction between learning-related factors and management-related factors, the interdependency shines through and indicates that group *discussions* are vital for developing the knowledge, skills and competences aimed for – as two groups formulate it in their process-analysis: “share the talking – share the thinking”.

Table 2. Factors significant for group discussions

	Goals	Activities	Tools	Personal issues
Democratic social relations	Participation Influence Ownership	Share Listen Initiate	Moderator Agenda Breaks Procedures and rules for group	Emotions Trust

			collaboration	
Co-constructing knowledge through co-elaboration	Understanding Documentation Variety of viewpoints	Preparation Presentation Argue Question Critique Think-talk-share	Coordinator Board Google docs Agreements on terminology Facts	Positioning
Shared control	Procedures Content Main thread Disposition Consensus Follow-up	Feedback Decisions Estimation Evaluation Sparring as verification	Production schedule Top-Tail Agreements on content, grammar and layout	Self-critical Trust

Table 3. Factors in focus during group discussions

Goals	Focus
Clarification and learning	Terminology; concepts; theories; models;
Shared understanding	Project-objectives and –goals; problem and problem-formulation; methodology;
Implementation	Functionality; procedures; solution;
Project planning	Scheduling; sequencing; resource allocation;

Based in the context of the factors identified in the process-analyses a new set of horizontal dimensions is proposed to be “project structuring and planning”, “shared understanding”, “learning and clarification” and “implementation” as these represent and reflect the interviewed project-groups’ understanding of their process. The original intention of applying the same vertical categories as in Table 2 is found to add no significant information not already available in Table 2. Table 3 is therefore reflecting loyally the focus as expressed by students in process-analyses as well as interviews.

4.2 Analysis of interviews

According to the groups, *discussions* that repeat themselves are more frequent in the early semesters due to lacking establishment of shared understanding of goals and due to lacking communication skills making group-members unable to handle (manage) the uncertainties of ill-defined projects. But most of all due to a more individualized approach and lack of adequate knowledge:

“Having read the textbook doesn’t provide adequate understanding of a concept nor terminology.” [D]

Someone opens a conversation and others join (sometimes just to position themselves) and an unfocused, unstructured *discussion* develops – until someone (who has capacity to observe the conversation) calls for a summary in order to secure consistency, or until someone (who may see no point in continuing the *discussion* or may be outright upset and exhausted) calls for a vote, or until someone (who may have other pressing activities scheduled) calls for a suspension of the group-meeting as such. Groups may also differentiate between “open modus” and “closed modus”: open modus defined as a divergent process predominantly characterized by a variety of viewpoints, while closed modus is defined as a convergent process predominantly characterized by aligning positions, verifying information and making decisions. In order to differentiate the group must call for a pause between the modes and thus enabling a focus on the aims and needs.

Exemplifying this group [A] explained how some *discussions* were allowed to continue as the outcome would be learning, whereas other *discussions* would be closed earlier in order to make a management related decision. Although fewer *discussions* were reported in this group – purportedly due to the fact that the group-members were quite familiar with each other after having collaborated through 2-3 projects – focusing the conversation still needed attention. Being more familiar with each other actually meant that group-members trusted each other to perform more thorough preparation and perform in-depth research leading to more precise and correct formulations – as opposed to a more extensive need for interpretation in groups with less common collaborative experience.

The conversations aimed at reaching (or creating or co-constructing) a shared understanding, are more prone to develop into the unfinished or undecided type of *discussions* – which may recur several times until the group has reached a sufficient level of comprehension to be able to settle the uncertainty. The needed comprehension may deal with academia, methodology or structure. Two other factors influencing the closing of *discussions* are time and patience; deadlines can be quite conducive to urge group-members to make a choice, and those with more patience (and words) are more likely to have an impact.

In group [B] a typical *discussion* (within the early project phase) may begin with a request/suggestion for a plan (schedule; overview) for the work to enable the project-progression. A suggested activity may spur a clarification of the activity and a related theoretical model which again leads the conversation towards the problem formulation – followed by comparison of theories/tools – then a detour around the initial problem-statement evaluating its validity before ending up with the requested plan expressing shared project-goals based on the shared understanding achieved through the conversation.

The group characterized this unplanned and unstructured conversation as a necessary "test of agreement" – "something you have to go through at some stage" for achieving shared understanding – as group-members otherwise "assume we agree". Some group-members had experienced having this type of conversation during the final 1-3 weeks of their earlier semester-projects explaining the late occurrence being due to insufficient familiarity with other group-members' thinking and a reluctance to open up issues which may disturb the assumed agreement and thus disturb work, progression and emotions.

In group [A] a typical *discussion* may originate in a desire to organize and handle data-collection properly or with an intention to align perceptions of the report-structure. The following comparisons of different approaches may not result in an actual plan or structure, but rather a clarification of "how should we plan" or "why should we structure the report a certain way".

Students' responses to Barrett & Moore's (2011) principles were initially reluctant and marked by uncertainty of the meaning behind the principles, however they quickly defined "co-constructing knowledge through elaboration" as similar to their learning efforts. The "democratic social relations" is seen as a continuum where the focus relates to the development of trusting and helping each other, and similarly the "shared control" comprises issues of responsibility, interest and contribution. Students stressed that an extra principle "shared goal/product" seemingly is missing. Engineering students' are deeply engaged in systematizing, analyzing, planning and measuring in their efforts to solve the project-problem:

"We are applying theoretical knowledge to a practical problem." [C]

As groups become more conscious of the project-process and attains a more holistic perception of performing a study-project it also becomes obvious that *discussions* serve as a means to produce output that ultimately becomes input to another part of the project. And while students during early semesters perceive ownership as the right and plight to defend their personal writings and react hotheadedly possessive, students at later semesters will perceive ownership as a group achievement that cuts away any individualistic and possessive claim regarding insignificant project-issues.

5. Findings and discussion

5.1 Origin of group-discussions

Based on the interviews with student-groups it appears that *discussions* originate in a:

- lacking transparency or consensus;
- disagreement or a wish to define/clarify/rectify;
- deliberate intention to attain deeper knowledge;
- deliberate intention to manage the process and/or to structure the project/report;
- deliberate intention to reframe, rethink, restructure and/or innovate.

The reasons listed are apparently all based in a striving to achieve results which in students' words mean doing "what's making us engineers".

5.2 Discussion as media

Like in the communication exercise mentioned in the Introduction, the communication among the participants serves as a means to achieving results – solving the mystery or in engineering terms: solve the problem with a procedural or functional construct. Solutions do not appear out of the blue, only based on solid and verifiable knowledge which (in learning terminology) serves as ingredients in the students' co-constructing through co-elaboration – which in project-management terminology is equivalent to a coordinating process.

Citing Willert (2011) who in his terms specify "learning mediated through languageing" where students "adopt new language patterns or codes, thereby, hopefully, helping them to gain a richer understanding of the world or to become more adept at handling it in action." *Discussions* thus serve as media for coordination of meaning (Pearce, 2007) – the *discussion* results (goals, plans, procedures, activities or tools) being expressed as coordinated management of meaning.

As reported from the interviews unstructured approaches are most common, however it appears that approaches become more and more systematized and professionalized as experience accumulates and skills and competences emerge – ultimately securing conversations from the "pitfalls and dangers" listed in table 1.

5.3 Discussion as engineering tool

For Henriksen (2011) the coordination or negotiation process is clearly a co-construction of a new meaning or a new understanding which as a shared effort dissolves the conflicts that otherwise impede project progression. Awareness and professional competences enables quality conversations – a serious recommendation to students of early semesters that homework actually does pay off immediately and in the long run. However, a significant learning that emerged from the communication exercise mentioned in the Introduction is that posing crucial and critical questions can at times serve as the most effective and efficient approach in problem-solving (learning).

When taking into account the cognitive abilities in Dixon's (1999) organizational learning cycle students confirm that their *discussions* affects all aspects of the learning cycle. Furthermore, the students appreciated the fact being involved in the full learning cycle and the full project-cycle, although they still find project complexity to be a unifying as well as a separating factor between management and "real engineering performance".

5.4 Discussion as diagnostic tool

Barrett & Moore (2011) propose their three principles as facilitators of the dialogic knowing central for groups engaged with PBL-tutorials. The principles coupled with a project-management view provide a useable and useful diagnostic tool for:

- assessing strengths and weaknesses in the group's approach;
- suggesting changes in the group's approach;
- making supervisory interventions.

6. Conclusion

In conclusion, this paper has sought to (1) find ways of facilitating students' handling of *discussions* in early semesters, and (2) find ways of motivating students for approaching *discussions* as a professional skill used by professional engineers. As regards (1) the overviews provided in tables 2 and 3 are proposed as diagnostic tools to assess strengths and weaknesses in the project-groups' approach. How this diagnostic tool may be applied is yet to be explored, but the evidence behind this way of thinking points towards formulating more durable explanations for what is making the Aalborg Model of PBL work.

As regards (2) the evidence provided proposes a stronger focus in the supervision and in the PBL-course raising the awareness of the potential in and the value of conversation competences. Communication exercises (like the "Murder at the Black Horse") and subsequent thorough analyses and follow-ups seem necessary in providing early-semester students essential eye-openers regarding best performance versus pitfalls and dangers.

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References

Barrett, T. & Moore, S. (2011). Students Maximising the Potential of the Problem-based Learning Tutorial: Generating Dialogic Knowing. In: Barrett, T. & Moore, S. (Eds.): *New Approaches to Problem-based Learning: Revitalising Your Practice in Higher Education*. Routledge, New York. (p. 115-129)

Dixon, N. M. (1999). The organizational learning cycle: how we can learn collectively. 2nd ed., Aldershot, Gover.

Henriksen, L.B. (2011). The engineering project and the concept of "implementation" – on engineers, project management, and "the thing itself". *Working paper presented at the Proceed seminar* – Aalborg 25-26 August 2011.

Merriam-Webster (2013). http://www.merriam-webster.com (accessed March 3, 2013).

Mosgaard, M. & Spliid, C.M. (2011). Evaluating the impact of a PBL-course for first-year engineering students learning through PBL-projects. In: 2nd International Conference on Wireless Communication, Vehicular Technology, Information Theory and Aerospace & Electronic Systems Technology (Wireless VITAE). IEEE Press.

Pearce, W. B. (2007). Kommunikation og skabelsen af sociale verdener (Communication and the making of social worlds). Dansk Psykologisk Forlag.

Spliid, C.M. (2011). Mastering projects and processes in the Aalborg PBL model. In: Davies, J., E. de Graaff & A. Kolmos (Eds.): *PBL across the disciplines: Research into best practice*. Aalborg: Aalborg Universitetsforlag. (p. 555-568)

Willert, S. (2011) Social construction of meaning and its translation into real world action: the problem of learning transfer and how to circumvent it. In: Horsdal, M. (ed.) *Communication, Collaboration and Creativity. Researching Adult Learning*. Odense: University Press of Southern Denmark.

Problem-Based Learning: A Process for the Acquisition of Learning and Generic Skills

Sadiah Baharom (sadiahzee@fsmt.upsi.edu.my)[a]*, Balachandran Palaniandy[b]

[a]*Department of Science and Mathematics, University Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak Malaysia*
[b]*School of Pre-U Studies, Taylor's College, 47500 Subang Jaya, Selangor, Malaysia.*

Abstract

This research seeks to explore how problem-based learning (PBL) supported learning and the acquisition of generic skills in pre-university college students. Eighty participants from a local private institution participated in this study. The topic of study was the inheritance of Huttington's disease, under the subject of Genetics. Students were trained in two PBL learning sessions on another topic before the actual intervention. Feedback on the implementation of PBL were gathered through written responses at the end of the three-week PBL session. Analyses of the written responses showed the strength of PBL in supporting learning and the acquisition of generic skill. Students reported positively in terms of acquiring various skills such as problem solving, critical and analytical thinking, communication, team work, life-long learning and self-directed learning. This research further support the value of implementing PBL as an approach towards teaching and learning.

Keywords: Problem-based learning, thingking skills, communication skills, team work skills;

1. Introduction

In the quest of developing a scientific and progressive society, the Malaysian Government has taken measures to enhance the potential of Malaysian education in moving the nation towards a knowledge society. In a scientific society, the entity of an individual is as important as the society shift. This paradigm shift is important to the nation's growth and calls for intellectuals and academicians in the education world to be forward looking, versatile and multi-disciplinary. The significance of this shift is to reshape the education system and draw global attention towards the country's educational potential. A comprehensive and constructive education system has the potential to develop students who are critical thinkers and innovators who will be able to contribute to the development of the nation.

Learning in the 21st century entails personal meaning making and construction of knowledge. This process is encouraged through student-teacher active interaction and social negotiation among peers. However this approach demands new teaching methods and strategies as well as greater empowerment of learning onto learners. The process of teaching and learning for the 21st century advocates lesser teacher centeredness and greater student centeredness to support the development of not only meaningful acquisition of concepts but skills in thinking and reasoning. An effective teaching and learning approach must not only develop students intellectually but also affectively. In attaining the holistic individual as aspired by the National Philosophy of Education, the learning process must progressively develop students with the necessary generic skills, which are crucial to effectively function and compete locally and abroad.

2. Background of Research

The current teaching and learning experience in schools and colleges in Malaysia is still very much didactic. Most teaching practices a one-way pedagogical model where the students are passive recipients of knowledge, the teacher as the provider of knowledge and learning is more rote than meaningful. As a consequence there exist minimal interactiveness to support productive learning least developing thinking or generic skills. It has also been shown by numerous research that passive learning settings does little to promote deep conceptual understanding of fundamentals concepts.

What does it take to teach Biology to be relevant and practical to human life? Problem Based Learning (PBL) could be the answer to this. It is an excellent strategy where learning begins with a problem naturally occurring in everyday life that bears relevance and meaning to the students. The problem posed triggers students' past experiences and prior knowledge. These serves as the foundation to anchor new concepts acquired through the PBL process. Since PBL involves collaborative learning, students gain more confidence while working through and addressing the problem posed. PBL is a teaching and learning process that integrates non-traditional in-class instruction that is constructivist in nature and empowers student centred learning. When learning through PBL, students acquire multifaceted skills cognitively and affectively.

Corresponding Author name. Sadiah Baharom
Tel.: +612 4730 432
E-mail address: sadiahzee@fsmt.upsi.edu.my

According to Savin-Baden (2000), PBL is an approach to learning that is characterised by flexibility and diversity in the sense that it can be implemented in a variety of ways in different subjects and disciplines and in diverse contexts. PBL have the functional entity in allowing the development of higher order thinking among students and thus promotes an analytical mind. In PBL, students also experience materializing scientific information where there is "pursuit of meaningful knowledge through the use of procedures that are thoughtfully generated and evaluated by those who are asking questions" which is part and parcel of a scientific inquiry (Palinscar et. al. 1993).

An important feature of the PBL process is making reflections at the end of the PBL process. This happens in the last stage of the PBL process. Reflections can be defined as a complex process of thinking in which students can reflect and comment critically about their strengths and weaknesses highlighting areas for development (Lin, 2009). Students' reflections will also enhance their passion and pursuit for seeking explanations and solutions to scientific phenomena surrounding their everyday life. This research aims to understand how PBL contributed towards strengthening learning and developing generic skills crucial to the development of holistic individuals.

2. Problem Statement

Biology in Malaysia is taught with a specified curriculum and syllabus. To many students the depth and breath of the biology content is overwhelming and detered them from embracing the subject with ease and confidence. This is compounded by the complexities and intricacies of structures and functions, terms and terminologies, and mechanisms and processes involved in learning the subject. To a naïve student this may prove too laborious and irrelevant. If the teaching and learning of Biology remained teacher-centred, exam oriented and painstaking memorization of facts and concepts, students will choose to learn subject that offer more authentic and practical applications of knowledge. This aspect could be one of the contributing factors to the dwindling enrolment in the sciences at the higher education level.

Genetics and Inheritance has been reported as topics that are difficult and abstract. Misunderstandings and misconceptions has always prevailed in the teaching and learning of genetics. Past research have identified several problematic areas in studying genetics. Students have difficulty understanding the very basic units of genetics such as chromosomes, genes or allelles (Collin and Steward, 1989; Albaladejo and Lucas, 1988); they cannot adequately interpret concepts such as homozygous or heterozygous (Slack and Steward, 1990); they have alternative views of the mieosis and mitosis process (Kindfield, 1994; Brown, 1990; Stewart et al., 1990); and they could not fully understand the meanings of probability in relations to genotype and phenotype frequencies (Browning and Lehman, 1988; Cho et al., 1985). However bearing in mind that the study of genetics has important impact in various aspects of life such as medicine, food production, health and lifestyle, new approaches and methods must come into place to teach and learn genetics more effectively and meaningfully. On that note, the researchers believe that the PBL approach to teach the topic of genetics and inheritance could offer a more constructive and meaningful learning experience for the students.

Students graduating from higher institution in Malaysia are often faced with criticisms from employers, especially from the private sectors, pertaining to their lack of communication, team work, problem solving and analytical skills. These skills are the generic skills or more commonly known as the soft skills that students need to acquire before leaving the institution. Acting upon the poor evaluation by the private sectors, the Ministry of Higher Education has announced that public universities in Malaysia must introduce soft skill elements and incorporate them in the undergraduate syllabus. Given this situation the researchers feel that PBL can offer an excellent platform for the development of generic skills.

4. Research Objective

This research aims to answer the following questions:

1. How does PBL help learning?
2. What are the generic skills developed during the PBL approach?

5. Literature Review

Problem-based learning (PBL) is an inquiry-based instructional approach in which students work in small groups to solve ill-structured problems. An ill-structured problem is defined as a problem with no clear solution or solution path (Hung,2003). PBL is used in medical schools and is now used in many educational settings (Barrows & Tamblyn, 1980; Gallagher, Stepien, & Rosenthal, 1992; & Torp & Sage, 1998). In PBL, students (a) collaboratively determine what they know and need to know, (b) research content and/or conduct scientific tests, (c) communicate research results among themselves, (d) collectively determine a solution to their problem, and (e) present their solutions to classmates (Hmelo-Silver, 2007).

According to Hmelo-Silver (2004) PBL is well suited in helping students become active learners because it situates learning in real-world problems and make students responsible for their learning. Educators are interested in PBL because of its emphasis on active, transferable learning and its potential for motivating students. Agran, Blanchard, Wehmeyer, and Hughes (2003) argued that students must develop their problem-solving skills in order to succeed in life. Given that PBL can increase the problem-solving skills of university, gifted, and average students (Barrows & Tamblyn, 1976), mainstreamed students may benefit from PBL in similar ways.

Students must also be given the opportunity to develop self-directed learning (SDL) skills in order to succeed academically and personally (Wehmeyer *et al*., 2000). SDL skills refer to students' abilities to initiate appropriate actions to gain knowledge or skill (Gibbons, 2002). PBL has been shown to increase the SDL skills of advanced students (Evensen, Salisbury-Glennon, & Glenn, 2001). The PBL approach improves students' ability to analyse, synthesise and evaluate situations thus cultivating the habits of using the higher order thinking and reasoning skills.

In the PBL process students are required to give feedback and make reflections on their learning. Making reflections is a metacognitive skill which play a key role in the metacognitive process of self-directed learning (Ertmer, 1996). Making reflections help students to become aware of their mental structures, subject them to a critical analyses and if necessary, restructure them accordingly (Korthagen, 2001). Reflection is also intended to enable students to assess their own growth and changes in their thinking over a period of time.

Salomon (1989) mentioned that reflecting on the relationship between problem solving and learning is a critical component of PBL and is needed to support the construction of extensive and flexible knowledge. Reflection helps students (a) relate their new knowledge to their prior understanding, (b) mindfully abstract knowledge, and (c) understand how their learning and problem-solving strategies might be reapplied. Hmelo-Silver (2004) claims that student reflections refer to specific behaviors exhibited through both positive and negative comments from students. These comments provide others in their group with information they can use to improve their effectiveness as collaborators and their self-directed learning ability.

Moving on to the acquisition of generic skills, the institution of higher learning in Malaysia faces a huge challenge in producing students who are not only excellent in knowledge but excel in terms of skills in the workplace. Currently both local and global workplaces are demanding workers with high employability skills such as basic skills, thinking skills, and interpersonal competencies. A survey done by Richens and McClain (2000), claimed that most employers require that entry-level workers possess good employability skills rather than technology competencies. According to Wilhelm (2002), employers assert that too many high school and college graduates do not possess the skills necessary to contribute productively in their jobs. To address these problems the Malaysian Ministry of Higher Education has taken steps to identify the major soft skills deemed necessary to improve marketability and employability of students leaving the higher institution. Seven major elements of the generic skills were identified, of which communication, problem solving and critical thinking, teamwork, lifelong learning and information management was explored in this study.

6. Methodology

This research is an exploratory study on the ability of PBL to promote learning and skill acquisition during teaching and learning. This intervention explored the ability of PBL to promote the much needed generic skills in students. These generic skills include communication, critical and problem solving, team work and life-long learning skills. Apart from this, the research explored how PBL help students learn through their group discussions and interactions. Sampling of the students was done through a non-probability purposive sampling that uses intact groups of students These were students enrolled in a Pre-University programme of a private college. Four different classes were taken as samples for the study. The total no of students were 80. These students went through a PBL session studying the topic of Genetics and Inheritance with a special focus on Huntington's Disease.

Students were grouped randomly as heterogeneous sample with 5 students to a group. A total of 16 groups were formed. Students were briefed on the PBL approach with two examples of a PBL scenario before starting with the actual intervention. This step was taken to familiarize the students with the different stages of PBL. The study was conducted for 3 weeks with a 4 hours face-to-face contact with the facilitator each week. The PBL scenario was introduced during the second stage of the PBL process followed by generation of learning issues individually and as a group. After the seventh stage of the PBL process, written reflections on learning through the PBL approach were collected from the students.

7. Data Analysis

Students in this study responded to two main reflective questions given by the researcher. These questions were:

1. How PBL helped you in your learning?
2. What are the skills you acquired in the process of learning through PBL approach?

These reflections were manually analysed and coded into more general themes. The steps for this process were: (1) selecting relevant ideas (2) discovering repeating ideas (3) organizing repeating ideas into themes and (4) creating narratives to describe the research concern.

8. Results

Written responses were analysed and identified for the purposes of answering the two research questions formulated. These responses were discussed in two main sections that is 'How PBL helped learning and skills acquired during learning through PBL'.

8.1. How PBL helped students learn

Some of the major contributions of PBL in the learning process include achieving a higher level in the learning outcome, acquiring specific science process skills, inculcating the scientific mind, meaningful learning, increased knowledge acquisition and motivation.

8.1.1. Improved learning

One student's response to this aspect was:

"PBL instil higher order thinking within me as the approach requires me to be aware of mental blocks that can lock me into a fixed way of doing a particular thing in a specific manner." (PM 13 080)

Further students' reflections supported this view:

... I also can learn how to elaborate points better and take suitable action to solve a problem	(PM 5 015)
"*... I have realised that PBL will give much momentum for me to study, analyse, and make probable assumption and variables..*	(PM 5 019)
" I have to use the biological way of thinking and apply the knowledge of biology in my thinking."	(PM 13 052)
"*.. ability to define problems, gather and evaluate information*	(PM 5 013)
"*I learnt how to research a problem and analyze the key factors of a case scenario.*	(PM 5 014)
as I learn to compare and decide on correct information regarding the scenario"	(PM1 001)
all the information that is needed and the unnecessary ones	

8.1.2. Acquire scientific skills and inculcating the scientific mind

The various ways PBL supported learning in terms of acquiring scientific skills was clearly manifested in this study. Written responses that supports this notion include:

"*collecting and filtering information and points are essential. We also learnt how to relate questions in order to rethink and* pose a new questions *which requires someone to elaborate more"*	(PM 13 042)
Analytical skills can be acquired too, as it requires thinking for the FILA chart where we need to sort out.	(PM 8 018)
"PBL has helped me to find the accurate and best solution by following the whole procedure which will lead to the solution in end, ... to look things with different angle."	(PM 5 022)
... I also learnt to be more observant..."	(PM1 004)
and it raised my curiosity about many things…."	(PM6 040)
"PBL made me more inquisitive and helped me *in researching further on the topic*	(PM 6 030)
PBL inspired a need for critical thinking and logical investigation when considering a problem".	(PM 5 014)

8.1.3. Meaningful learning

The ability to understand and adapt to novel situations were evident in these responses:

"*I learned that understanding is more important than memorizing facts and will help me* (PM 5 025) *to learn new things through PBL approach."*

with PBL's hands-on approach - a two-way process that directly links knowledge and application that just doesn't happen in traditional learning methods." (PM 5 014)

PBL is self- learning, involves discussion among friends and also individual which steer self-directed learning instead of being fed with knowledge by the teacher." (PM 13 043)

"I have learnt to rephrase my sentences correctly and improve my grammar and vocabulary." (PM 13 050)

8.1.4. Increased knowledge

Analyses of the students' responses revealed that the PBL sessions helped students increase their knowledge acquisition. Some of these responses are:

I have broaden my horizon and learnt in depth of the topic. It was also more interesting. (PM 6 030)

"*it has helped me to broaden my knowledge of the problem given*" (PM1 006)

" ... we get to pay particular attention to one subtopic only, hence we could acquire more knowledge… (PM 13 049)

" ...learning the new information from researches done by team members involves sharing of information between members will broaden the insights of content. (PM 1 005)

"*it has helped me to broaden my knowledge of the problem given*" (PM1 006)

"*PBL helped to make learning easier. The base concepts were easier to grasp. It motivated me to learn more, to probe deeper.*" (PM5 014)

This was also supported by another response which quotes:

8.1.5. Motivation

There was also evidence that students developed the use of non-verbal skill such as writing skill.

"PBL had me more interested about the topic discussed… (PM 6 040)

"It is teamwork that we can learn through PBL. We work together as a team and somehow managed to get the FILA chart done. This feeling actually motivates us and helps us to be passionate learners." (PM 5 018)

The base concepts were easier to grasp. It motivated me to learn more, to probe deeper. Furthermore, retention of the things learnt was so much easier (PM5 014)

8.2. Acquisition of skills during the process of PBL

The data from open-ended responses were carefully studied and repeating themes and ideas were categorized. There are mainly four skills that students frequently wrote about: (i) communication skill, (ii) critical thinking and problem solving (iii) teamwork and (iv) lifelong learning and information management skill.

8.2.1. Communication skill (CS)

Majority of the students mentioned about the improvement of their communication skills throughout the PBL learning. The essence of PBL was communication between the members in the group. The students also agreed and believed that they had greatly benefited from it, especially those few who were introverts. The responses below described this view:

" I learnt some communication skills and developed some analytical skills" (PM1 004)

"I have learned to be more socialise and can communicate better with my friends through PBL . This is because we need to communicate with others and discuss among ourself to get the FILA chart done. (PM5 015)

" *.. speaking skills are more developed as well when presenting our findings*" (PM 6 038)

Some of the responses were sub-skills for communication such as ability to communicate ideas clearly and confidently during presentations.

"I am able to <u>present to my friends with more confidently</u> and address the queries with relevant information. I feel so happy about this". (PM 13 074)

"*...before this I am quiet and sometimes don't talk publicly especially to present. Now I think I have improved and <u>able to do presentations without fear</u>.*" (PM13 077)

8.2.2. Critical Thinking and Problem Solving

Several responses from students for the various critical thinking and problem solving are listed below. The summary of the skills are categorised into three skills namely; ability to identify and analyse ill structured and complex problems and make justified evaluation, ability to develop and improve thinking, and thinking out of box/creative thinking. Students are able to meet the problem when they first encountered it. Transforming information is also important key to problem solving in PBL. Some students' responses supporting this notion include:

...<u>develop solutions</u>, team skills ... and also the ability to use all skills to address problems in a complex real- world setting." (PM 5 013)

Brainstorming the issues present in the problem given taught me how to view facts objectively, from all sides. The idea of <u>questioning a fact thoroughly</u> was something I came across over and over again when working with the PBL group. (PM 5 014)

Students viewpoint in thinking out of the box were evident through these responses:

" I developed the <u>ability to think out of box</u>"

"*I learned <u>to think differently</u> and creatively to solve the scenario as it requires to think really hard to learn through the approach of PBL."* (PM 1 008)

8.2.3 Team Work Skill

In terms of skills attained working in teams, findings from this research suggest that students foster a healthy relationship, engage in group discussion and negotiation, and work together effectively to achieve a consensus on problem solutions. Most responses from the students mentioned that compatibility among other peers gradually increased as they go through the PBL process.

One particular evidence of this is:

"Moreover I'd learnt to <u>be more active in group</u> and discussed with team mates." (PM 13 069)

The value of working as a collaborative team was expressed in the following statement:

"Be more active and required me to more engaged in learning n stimulates critical and creative thinking, compare and <u>share learning strategies</u> and self learning, the team work in summary I most enjoy in PBL." (PM 13 065)

When confronted with differing ideas and behaviours, students developed the ability to recognize and respect behaviours and beliefs of others:

"I have acquired the <u>skill of working together</u> and discovered is more fun and tend to solve problem faster. I <u>also respect and am open to others opinion</u>." (PM 5 016)

The students also developed the ability to contribute in planning and monitoring of group output. Some students seemed to be very objective and goal orientated and inspired others in team. Some written responses say:

"Skills such <u>understanding among members</u> also important, especially when there is a situation among members, we need to understand the situation and think the best solution in order to prevent any misunderstandings." (PM 5 022)

Some students also mentioned about gathering a new horizon and being responsible for group decisions:

"I polish through my attitude; <u>I am more responsible</u> to my group and its meeting." (PM 13 077)

Students also develop the ability to practice active listening skills and giving feedback:

"...<u>tolerating and accepting ideas</u> and viewpoint from different members are openly (PM 5 024)

practiced".

"I have learnt the skills of collaborating with teammates in achieving a common goal. Negotiation skills are important when putting forth an idea that can be accepted by the whole team. It is important to consider my teammates ideas.	(PM 6 029)

8.2.4. Life Long Skills and Information Management

As the nature of the PBL assignment is ill-structured and open ended, students need to develop knowledge and skills to search and manage information. They discover their ability to find and manage relevant information from various sources. Some students responses concerning this include:

"I have learned to use the library resources."	(PM1 011)
"The process of learning through PBL is selecting information *and finding out main problem*	(PM 5 026)
In addition to that, it helps us to improve our skills in compiling the materials and sort it properly."	(PM 6 039)
"I have also learnt how to obtain journal online using reliable sources to quote from. I have also learnt how to cite journal and prepare a full bibliography."	(PM 6 028)

9. Discussion

The PBL process advocates the notion of 'learning how to learn'. At each stage of the PBL process students are needed to think of ways to solve a given problem, and make decisions to apply relevant concepts to justify the proposed problem solutions. As observed in this study, during the PBL sessions students learn through 'elaborating points', 'analysing, comparing, synthesising, and evaluating information' concerning phenomena presented in the problem scenario. It was evident that during the PBL process students displayed learning outcomes at the higher level of the Bloom's taxonomy thus reinforcing that PBL help improve students' learning. Learning becomes more substantial through group discussions and facilitation where students communicate, negotiate, and consolidate their ideas to achieve the learning goal. Students learn through exchanging and brainstorming of ideas within the group, reaffirming facts presented by members and validating information obtained from various sources. These findings supports most past research advocating PBL as an approach that supports learning.

Findings from this research supported the view that PBL plays a crucial role in developing scientific skills and inculcating the scientific mind. In this study students collected and filtered information, observed situations, ran investigations and researched relevant ideas to support proposed solutions. Much of the learning in PBL require students to develop learning issues to address the given problem. Learning issues are usually phrased in the form of questions to the ideas generated during group discussions. As learning progressed students showed an increased ability to ask higher order thinking questions, focussing more on the 'why' and 'how' of the phenomenon studied. Instances of students developing, rephrasing and asking higher order thinking questions were evident in the reflective journal transcripts. Students became curious as intriguing questions emerged through analysis of the problem scenario, thus further deepened students' interest to learn more about the phenomena studied.

A lot of efforts have been made to move away from didactic teaching in pursuit of making learning more meaningful. Students' responses in this study suggests that PBL had this potential. Students reported that the PBL sessions made them realised that 'understanding is more important than memorising facts' and 'links knowledge and application' of concepts. The PBL process also 'encouraged self-directed learning instead of being fed with knowledge by the teacher'. These responses strongly suggests that PBL could play a big role in promoting meaningful learning. In terms of knowledge acquisition PBL helped students 'learnt in depth', broaden knowledge' and promoted deep learning. On at the affective side, PBL motivated students to be passionate towards the subject matter.

Analyses of the critical thinking and problem solving have been very closely related to the ability of identifying and analyzing ill structured and complex problems and developing a justified assessment. Response from the students indicated that PBL could be an effective approach to develop critical and problem solving skills. Their critical thinking is very closely related to the cognitive functions such as configuring, relearning, rethinking, recognizing and making patterns, connecting, imaging, and playing with ideas. As shown through the students' responses, this possibility is integrated in the PBL process where teaching and learning kick starts with a problem. The student also developed the ability of thinking out of the box which may lead to creative problem solutions. Creative thinking moved students from their comfort zone in an effort to try different perspectives using different points of entry. Students can use various methods including provocations to solve the problems.

It was also observed that students' ability to understand and adapt to novel situations was stimulated by the nature of a scenario that was unfamiliar to them. Students brought strategies and beliefs about learning to a new situation and adapt their personal strategies to the situational demands. In this study students often had difficulty initially adapting to the PBL approach but progressively improve their skills in dealing with ill-structured problems.

The PBL approach imparts beneficial characteristics to learner's needful development holistically. The term "holistic" has entered the educational arena to promote a view that an attention to wholeness is more important than attention to the separate and contributory part. Some of the skills that was evident from this study were communication, critical thinking and problem solving, team work and lifelong learning and information management skill.

PBL offered the potential to help students become reflective and flexible thinkers who used knowledge to take action and eventually became effective communicator. This study showed students developed communication skills through engagement in group dialogue, sharing of ideas during the PBL facilitation and presenting and communicating problems solutions. This promising result showed students were actually promoted to active learners as warranted by the constructivist paradigm of teaching and learning.

Good problem-solving skills was translated into the ability to define the problem when given an ill-structured situation. This ability calls for skilful analysis and accurate problem identification. Findings from this study showed that communicating and negotiating with team members helped students analyse and understand difficult situations and collectively decide on problem identification and finally resolving it. Through these processes student were able to grasp difficult concepts of Genetics and apply these concepts to more novel situations. This findings was mirrored in a research done by Norman *et al.* (1998) who found that students in PBL curricula transferred the hypothesis-driven reasoning strategy to unrelated problems and generated more coherent explanations than students without PBL experience suggesting that they have developed better problem solving strategy.

The support for team work skills is clearly evident in the students' responses. This finding is supported by research done by Schmidt and Moust (2000) which indicated that group function is the most important aspect of PBL because it affects learning outcomes and intrinsic motivation (Schmidt and Moust, 2000). In this study students enjoyed working in groups and were able to accept new ideas from team members and cooperatively work towards achieving a common goal in the learning process. Another support was through the research done by Nora Abdul Hak (2004) who found that students in her class believed that PBL had developed their ability to manage group dynamics, helped them in building their confidence working in a team and provided better cooperation between male and female students. Students also perceived that teamwork is better than individual work by motivating them to face the challenges of their study.

The students also developed lifelong learning skill and information management during the PBL process. One of the benefits of PBL is its claim to prepare lifelong learners because of its emphasis on self-directed learning (SDL). Responses showed that students on average agreed that they enjoyed learning independently and learning to make collective decisions in group work. Some of the lifelong learning skills observed in this study were students' activities in using the library to search for information, selecting and sorting relevant information, citing and preparing a full bibliography of information. These findings support the work of Hmelo-Silver (2004) who suggested that, because the problems used are complex, students work in groups, pool their expertise and experiences, and together grapple with the complexities of the issues presented. This finding is also supported by Blumberg (2000) who mentioned that if self-directed learners can define their own learning needs, assess salient information independently, and evaluate effectively the adequacy of their learning, then they should be able to function as lifelong learners. Acquisition of a strong knowledge base and superior soft skills will ultimately increase their chances of job opportunities in the market.

10. Conclusion

Reflections from the students established the notion that PBL allowed students to improve their learning and develop their generic skills through active participation during the PBL process. This approach allowed them to handle authentic problems and work in teams to come up with effective problem solutions. They also developed a common goal in formulating strategies to handle different aspects of their learning. In summary, students' reflections in this research demonstrated improvement in various facets of learning. Their written responses suggest the acquisition of deep learning and crucial generic skills to better prepare them for future real world experiences and challenges. It is apparent that learning through PBL improved students generic skill which could contribute to the development of their employability skills and increase their marketability locally and abroad.

References

Agran, M., Gilberts, G. H., Hughes, C., & Wehmeyer, M. (2003). The effects of peer delivered self-monitoring strategies on the participation of students with severe disabilities in general education classrooms. *Remedial and Special Education*, 23, 279-288.

Albaladejo, C. and Lucas, A. M. (1988) Pupils' meaning for 'mutation'. *Journal of*

Barrow , H.S. & Tamblyn , R.N. (1980). *Problem based learning: An approach to medical education*. New York: Springer

Blumberg, B. "Evaluating the Evidence That Problem-Based Learners are Self-Directed Learners: A Review of the Literature." In D. H. Evensen and C. E. Hmelo (eds.), Problem-Based Learning: A Research Perspective on Learning Interactions. Mahwah, N.J.: Erlbaum, 2000, 199–226.

Brown, C. R. (1990) Some misconceptions in meiosis shown by students responding to an advanced level practical examination question in biology. *Journal of Biology Education*, 24(3), 182-186.

Browning, M. E. and Lehman, J. D. (1988) Identification of student misconceptions in genetic problem solving via computer program. *Journal of Research in Science Teaching*, 25, 747-761.

Cho, H., Kahle, J. B. and Nordland, F. H. (1985) An investigation of high school biology textbooks sources of misconceptions and difficulties in genetics and some suggestions for teaching genetics. *Science Education*, 69, 707-719.

Collins, A. and Stewart, J. H. (1989) The knowledge structure of Mendelian genetics. *The American Biology Teacher*, 51, 143-149.

Ertmer, P., and Newby, T. 1996, The expert learner: Strategic, self-regulated and reflective, *Instructional Science*, 24, 1-24.

Evensen, D. H., Salisbury-Glennon, J. D., and Glenn, J. (2001) "A Qualitative Study of Six Medical Students in a Problem-Based Curriculum: Toward a Situated Model of SelfRegulation." Journal of Educational Psychology, 2001, 93(4), 659– 676

Gallagher, S. A., Stepien, W. J., & Rosenthal, H. (1992). The effects of problem-based learning on problem solving. *Gifted Child Quarterly*. 36(4), 195-200.

Gibson, S. E. (2002). Using a problem based, multimedia enhanced approach in learning about teaching. Australian Journal of Educational Technology, 18(3), 394–409, Available at: http://www.ascilite.org.au/ajet/ajet18/gibson.html, Accessed 14/09/2010.

Hmelo-Silver, C. E. & Barrows, H. S. (2007). Facilitating collaborative knowledge building. *Cognition and Instruction*

Hmelo-Silver, C.E. (2004). "Problem-Based Learning: What and how do students learn?" Educational Psychology Review, Vol. 16, pp.235–266
Hung, W., Bailey, J.H. and Jonassen, D.H. (2003). Exploring the Tensions of Problem-Based Learning: Insights from Research. In D.S. Knowlton, and D.C. Sharp, (eds.), ProblemBased Learning in the Information Age. San Francisco: Jossey Bass.
Kindfield, A. C. H. (1994) Understanding a basic biological process: Expert and novice models of meiosis. *Science Education*, 78, 255-283.
Korthagen, F. A. J (2001). Linking practice and theory: The pedagogy of realistic teacher education Mahwah, New Jersey: Lawrence Erlbaum Associates.
Nora Abdul Hak, (2004). *PBL promotes teamwork among students: an experience in Ahmad Ibrahim Kulliyyah of Laws, IIUM.* In: Workshop on Problem Based Learning, December 2004, Ahmad Ibrahim Kulliyyah of Laws. (Unpublished).
Norman, G. R., Brooks, L. R., Colle, C., and Hatala, H. (1998). Relative effectiveness in clinical reasoning in forward and backward reasoning. Paper presented Paper presented at the *Annual Meeting of the American Educational Research Association*, San Diego, CA.
Palincsar, A.S., Anderson, C.A., & David, Y.M. (1993). Pursuing scientific literacy in the middle grades through collaborative problem solving. *Elementary School Journal , 93* (5), 643-658.
Richens, G. and McClain, C. (2000). Workplace basic skills for the new millenium. *Journal of Adult Learning*, 28(1): 29-34.
Savin-Baden, M.(2000). Facilitating problem-based learning: The impact of tutor's pedagogical stances. *Journal of Excellence in College Teaching*, 11(2/3) 97-111.
Schmidt, H. G., and Moust, J. H. C. (2000). Factors affecting small-group tutorial learning: A review of research. In Evensen, D., and Hmelo, C. E. (eds.), *Problem-Based Learning: A Research Perspective on Learning Interactions*, Erlbaum, Mahwah, NJ, pp. 19–51.
Slack, S. J. and Stewart, J. H. (1990) High school students' problem-solving performance on realistic genetics problems. *Journal of Research in Science Teaching*, 27, 55-67.
Solomon, J. (1989) The social construction of school science. In Millar, R. (Ed) *Doing Science: Images of Science in Science Education*, New York: Flamer Press.
Steward, J. H., Hafner, D. and Dale, M. (1990) Students' alternative views of meiosis. *The American Biology Teacher*, 52, 228-232.
student error. *Journal of Biology Education*, 25(3), 193-200.
Torp, L., & Sage, S. (1998). Problems as Possibilities: Problem-based learning for K-12 education. Alexandria, VA: Association for Supervision and Curriculum Development (102 pp.)
Wehmeyer, M. L., Agran, M., & Hughes, C. (2000). A national survey of teachers' promotion of self-determination and student-directed learning. Journal of Special Education, 34, 58-68.
Wilhelm, W. J., Logan, J., Smith, S. M., Szul, L. F. (2002). *Meeting the Demand: Teaching Soft Skills* [Electronic Version], 43-57.

Adapting PBL Instantiation to Promote Students' Engagement

N. Arana-Arexolaleiba *, U. Markiegi, J. Oyarzun and I. Velez

Engineering School
Mondragon University, Mondragon
E-20500. Phone: +(34) 943 253398

Abstract

PBL has been instantiated in different ways in each university. Authors like Savin-Baden, Kolmos and Andersen propose models and principles that help to understand the key aspects of PBL in general and of our PBL instantiations in particular. The goal of this study is to understand our PBL instantiations and establish a framework to help our faculty members to design PBL. As an experience, we have used this framework to promote students' engagement. This has been done tuning participant or student direction principle. We have made two experiences with the same students in two consecutive semesters of the 2nd year of Computer Science degree and Telecommunication degree of Mondragon University. In the first experience, the problem has been defined by teachers and in the second one by students. In order to measure the consequences in terms students' engagement, we carried out a questionnaire. Additionally, we have also measured deep learning using students approach to learning with Dolmans' PBL-R-SPQ questionnaire. In those experiences, we have observed that the students' engagement and the classroom climate improved significantly. We have also observed that the students approach to learning didn't change.

Keywords: PBL, Learning approach, PBL principles, Students' engagement;

1. Introduction

The engineering faculty of Mondragon University has established a common educational model for all the diplomas. It is a mixed model, where there are activities related to courses, at the beginning of the semester, and an interdisciplinary PBL at the end of the semester. The PBL can take 30-50% of all the ECTS (European Credit Transfer System) on each semester. Each students group can have a slightly different context where a series of technologies needs to be used in order to solve a problem. All the students need to achieve the predefined learning outcomes (Arana-Arexolaleiba 2011). At the end of the PBL, the students group build complex technological artefacts.

In the last 10 years, we have implemented different type of PBL. In some cases, the solution was known in advance by teachers. In other cases, teachers have only an idea of the solution and the students have freedom to propose his/her solution respecting some constraints (Learning Outcomes, material availability, deadlines,...). We have observed that the students' engagement is different in each type of project.

We have also observed that during those PBL the students focus a great amount of energy in artefacts building, but they tend to use trial and error strategy. We consider that this type of strategy is not suitable for understanding of theoretical concepts. In fact, they show difficulties to support their work from a theoretical point of view. We think that they have not learnt in depth. But what is deep learning? And, what are the main variables that affect deep learning in a PBL framework?

In conclusion, with this study, we aim to understand our PBL instantiation(s). The concept of PBL instantiation was firstly used by Savin-Baden (Savin-Baden 2012), as the process of implementing a PBL with specific characteristics. We would also like to establish a framework to help our faculty members to design PBL. As an experience, in this study, we are going to use this framework to promote students' engagement in a PBL and measure the consequences in terms ofr student's engagement and student approach to learning.

* N. Arana-Arexolaleiba. Tel.: ++34-943-253-398
E-mail address: narana@mondragon.edu

2. Review of the literature

The fundamental thesis of Illeris (Illeris 2007) is that all learning involves three dimensions: content, incentive and interaction. Those dimensions must always be considered in an understanding of any learning situation.

As Ausubel stresses, "*the most important single factor influencing learning is what the learner already knows*" (Ausubel 1978). Illeris lists 4 types of learning (Illeris 2007): Cumulative, assimilative, accommodative and transformative. The cumulative learning happens when we learn by heart. The assimilative learning happens when the impressions from surroundings are incorporated and linked with the previous knowledge. The accommodative learning happens when there is partial or full restructuring of mental schemes. And the transformative learning is like a catharsis, bigger than the previous accommodative learning.

Biggs (Biggs 2007) classifies students approach to learning in two types: deep and surface:

1. Surface learning approach: the motivation is just to carry out the task. The student tries to identify important items to pass the exam and just memorizes them.

2. Deep learning approach: is driven by internal motivation (or intrinsic motivation) and curiosity. There is a personal commitment to learning. New mental structures are built. If a student has success in a given task, his intrinsic motivation increases.

Biggs propose R-SPQ-2F (Revised Two Factor Study Process Questionnaire) (Biggs 2001) to measure students approach to learning. Dolmans (Dolmans 2010) has adapted this questionnaire to PBL context (PBL-R-SPQ questionnaire). In this study we have used Dolmans' questionnaire.

Biggs (Biggs 2007) also proposes SOLO taxonomy (Structural Observable Learning Outcomes). It has 5 levels. Each level represents a different rearrangement of mental schemes. Whenever more mental schemes are restructured, more relations are made among the concepts, and in consequence, deeper learning is achieved. We can say that students achieve deep learning if they achieve levels 4 & 5 (qualitative phase) of SOLO taxonomy. Unfortunately, during this study we were not allowed to adapt our PBL learning outcomes to SOLO taxonomy.

Some authors (Kolmos 2009) (Andersen 2002) claim that PBL has learning principles. On the one hand, Kolmos (Kolmos 2009) proposes 9 principles that can be captured in three approaches: Contents (Interdisciplinary, exemplary, theory and practice including research methodologies), cognitive learning (Problem, project, experience and context) and collaborative learning (Teams and participant directed). On the other hand, Andersen (Andersen 2002) suggests that PBL has four principles: Problem orientation, student direction, exemplarity and inter or trans-disciplinarity. As we can observe, both models share some of the principles.

Kolmos' model adds the "*approach*" layer. This layer helps us to find similarities with Illeris triangle. Content approach (interdisciplinary, exemplarity and theory-practice) is linked with the content dimension of Illeris (knowledge, skills and attitude). In addition, Kolmos' collaborative learning approach is about teamwork and participant direction, this approach is linked with Illeris's interaction dimension. Finally, cognitive learning approach is a specificity of PBL comparing with other teaching learning activities.

In our case, some of those PBL principles were difficult to change or we were not allowed (i.e. learning outcomes). In this study, we have focused our energy in participant or student direction principle. Reinforcing student direction involving them in problem definition, we expect to increase students' engagement. As it is quoted in (Bigge 2004), "*Once a person has chosen a goal, the person will behave in a manner intended to achieve that goal*". Bigge & Shermis stress that (Bigge 2004) "*For a 'problem' to be a problem a person not only needs to feel a tension in a situation but also needs to have some idea of the nature and cause of the tension.*" We would also like to obsever if there is any change in student approach to learning.

As we can see in figure 1 there are two PBL processes. The process shown in figure 1 (a) is teacher or system directed and the figure 1 (b) student directed process. In the figure 1 (a), students are only responsible of the analysis and development of PBL. In the figure 1 (b), students are responsible of the problem definition and can also be co-responsible of the evaluation.

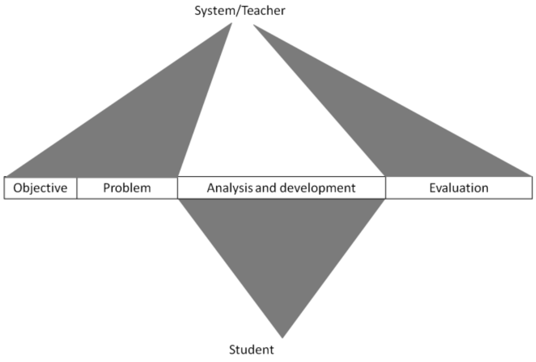

Figure 1. (a) Teacher directed process

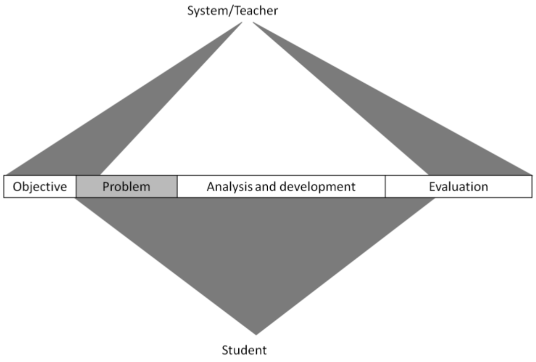

Figure 2. (b) Student directed process

Summarising, firstly, in order to increase students' engagement, we are going to instantiate a more student directed PBL, allowing them to define the problem they are going to deal with. Secondly, we are going to measure students' engagement with a PBL. And finally, in order to measure student approach to learning (deep/surface) we are going to use Dolmans' PBL-R-SPQ questionnaire.

3. Methodology and implementation

This experience was made in the 3rd and 4th semesters' PBL of Computer Science degree and Telecommunication degree (See figure 2). In both semesters, there is a 6 weeks long PBL. In the 3rd semester the problem was defined by the teacher team. Student groups were allowed to select among the predefined problems in a first come first serve basis. In the 4th semester, the problem was defined by the students themselves.

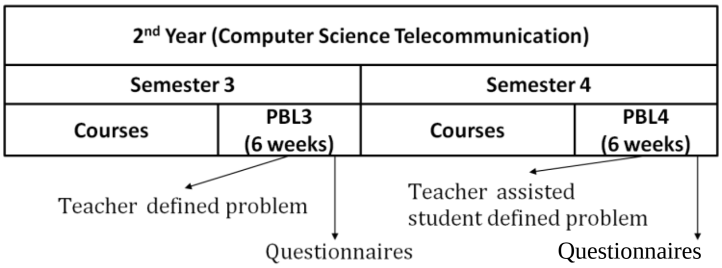

Figure 2. 3rd and 4th semesters implementation structure

At the beginning of the 4th semester (see figure 3), we had explained to students that they were allowed to define their problem, based on established learning outcomes. Students started thinking about the problem and sharing their ideas with the supervisors. At the end of the 9th week, student groups had submitted their proposals. Those proposals were validated by the supervisors.

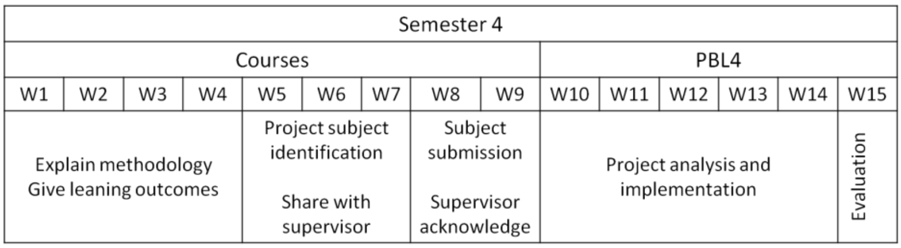

Figure 3. 4th semester problem definition and project implementation planning

During the 14th week of each semester (3rd and 4th) students were asked to fill out an "*ad-hoc*" questionnaire and Dolmans' PBL-R-SPQ questionnaire (Dolmans 2010). In the first questionnaire the items are rated also on a 1-5 scale (1=yes, I am agree with the statement, 5 not, I am not agree with the statement). Those questions were developed among three teachers from three different universities. In the PBL-R-SPQ questionnaire the items are rated on a 1-5 scale (1 = never or rarely, 2 = sometimes, 3 = half of the time, 4 = frequently and 5= always or almost always). The outcome of 17-items allows the researcher to determine student approach to learning: there is 8-item for deep learning approach and 9-item for surface learning approach.

In total 19 students (3rd semester – PBL3) and 18 students (4th semester –PBL4) filled out the questionnaire, giving a response rate of 67.8% in PBL3 and 64.2% in PBL4. The average age of students when entering the programme was about 19 years and most (about 71.4%) of the students were male. The study was conducted using a web tools and respecting the anonymity of students' responses.

4. Results and discussion

There were 7 student groups, each one with 4-5 students. 6 student groups (out of 7) proposed their own project subject and one team proposed 7 project subjects.

As we can see in the next table students items related with students' engagement were already positive in the PBL3. Most of the items are lower than 2.5. But all those items have significantly improved in the PBL4. The results agree teacher opinion.

Table 1. Students' engagement

	PBL3 (19/28)		*PBL4 (18/28)*		*Std mean Dif*
	Mean	*SD*	*Mean*	*SD*	*Cohen's d*

I have participated in a lot of discussions	2.94	0.66	2.25	1.00	0.85
I have felt very confident in the decisions/conclusions throughout the course	2.35	1.00	2.00	0.97	0.37
We really liked the problem we were assigned	2.00	0.94	1.38	0.62	0.81
We have always believed the problem was affordable for us and we were going to succeed	1.88	0.99	1.63	0.96	0.27

In this study, we have also measured other items (see table 2) linked with the classroom atmosphere. As we can see in the table 3, both items has changed improved significantly (Cohen's d 2.68 and 2.04). Those results also agree teacher opinion.

Table 2. Classroom atmosphere

	PBL3 (19/28)		***PBL4 (18/28)***		***Std mean Dif***
	Mean	***SD***	***Mean***	***SD***	***Cohen's d***
The atmosphere of the classroom has given me the freedom to use my own judgment	3.82	1.01	1.63	0.62	2.68
I have been able to make my own decisions	3.06	1.03	1.44	0.51	2.04

Finally, we have measured students approach to learning using Dolmans' questionnaire. As we can see in the next table in both PBLs students reported deep learning approach PBL3 (M=3.161, SD=1.16) and PBL4 (M=3.14, SD=1.17). On the other hand, the absolute value of standardized mean difference (Cohen's d) between both PBLs is lower than 0.049 (see Table 1); this means that statistically we cannot consider as a significant change.

The standard deviation in both approaches was quite high, if we compare with other references like (Dolmans 2010). There could be several reasons: different learning experience in the semester, different pedagogical background of the supervisors, different type and level of the learning outcomes or different assessment experiences among others.

Table 3. Computer Science and Telecommunication degree

	PBL3 (19/28)		***PBL4 (18/28)***		***Std mean Dif***
	Mean	***SD***	***Mean***	***SD***	***(Cohen's d)***
Deep learning approach	3.161	1.16	3.145	1.17	0.014
Surface learning approach	2.254	1.1	2.308	1.13	-0.049

5. Conclusion and future studies

This study has helped us to have a better understanding of the key aspects of PBL in general. PBL principle models have been helpful to have a wider view of PBL "*world*". These models also give us principles that can be tuned in order to adapt PBL methodology and create a particular instantiation. In this study, we have used to increase students' engagement tuning participant direction principle. This model has also been useful to share among staff members (old and newcomer) participating in those PBLs our particular instantiation characteristics.

From a practical point of view, with those models we have increased significantly students' engagement and the classroom atmosphere. The students were not only active but they also acquired the project ownership. They had a freedom to design their own solution. The numerical results and the teacher opinion agree. Anyway, a more reliable questionnaire needs to be developed in order to have statistically significant results.

We think that the students' engagement can be increased. If we see the figure 1 in this study we have only involved students in the problem definition, but we can also involve them in the evaluation process. For example, we can involve them in the definition of the evaluation criteria and self-evaluation and/or co-evaluation process of some of the learning outcomes.

The students, in both PBLs, have adopted deep approach to learning. Only reinforcing students' direction has not push student to adopt deeper approach. There is no significant change among both PBLs. As Gibbs (Gibbs, 2003) suggests, assessment can support the learning process. As Dolmans stresses, the "*Perceptions of inappropriate assessment may move students towards a surface approach*" (Dolmans 2010). The lack of deep learning outcomes and misalignment (Biggs 2007) between learning outcomes, assessment and PBL could be one of the reasons why in both PBL instantiations the student approach to learning is similar.

Finally deep learning can also be reinforced avoiding trial and error methodology. This method, naturaly used by the students, can be enriched by reflection and conceptualization phases of Kolb cycle. This process need to be facilitated by supervisors.

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References

Andersen, O.D. and V. Larsen. (2002). *Problembaseret Læring*, FoU-projekt nr. 2000-2734-91, DEL.

Arana-Arexolaleiba, N., Aldekoa-Anton, G. & Markiegi-Gonzalez, U. (2011), *Development of feedback process for competence based program*, Pbl Across The Diciplines:Research Into Best Practice, eds. J. Davies, Erik de Graaff & A. Kolmos, Aalborg University Press, Aalborg, pp. 502.

Ausubel, D.P., Novak, J.D. & Hanesian, H. 1978, *Educational psychology: a cognitive view*, Holt, Rinehart and Winston.

Bigge, Morris L. & Shermis, Samuel S. (2004) *Learning Theories for Teachers*, sixth edition, Pearson.

Biggs, J. & Tang, C. (2007), *Teaching for Quality Learning at University*, 3rd edn, Open University Press.

Biggs, J., Kember, D. & Leung, D.Y.P. (2001), *The revised two-factor Study Process Questionnaire: R-SPQ-2F*, British Journal of Educational Psychology, vol. 71, no. 1, pp. 133-149.

Dolmans, D.H., Wolfhagen, I.H. & Ginns, P. 2010, *Measuring approaches to learning in a problem based learning context*, Int J Med Educ, vol. 1, pp. 55-60.

Gibbs, G. (2003). How assessment influences student learning. If Reform of University Science Education is the Answer - what were the Questions?, Proceedings from the 3rd, DCN Conference,

Illeris, K. (2007), *How We Learn: Learning and non-learning in school and beyond*, Taylor \& Francis.

Kolb, D. (1984), *Experiential learning: experience as the source of learning and development*, Prentice-Hall.

Kolmos, A., Erik De Graaff & Xiangyun Du (2009), *Diversity of PBL – PBL Learning Principles And Models* In Research on PBL Practice in Engineering Education, eds. Xiangyun Du, Erik de Graaff & A. Kolmos, Sense Publishers, pp. 9-21.

Lizzio, A., Wilson, K. & Simons, R. 2002, *University students' perceptions of the learning environment and academic outcomes: implications for theory and practice*, vol. 27, no. 1, pp. 27-52.

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An Exploratory Study on the Implementation of POPBL among Lecturers of Higher Education Institutions in Malaysia.

Wan Azizun Wan Adnan[a] , Roslina Sharif[a] ,Ruhizan Mohammad Yasin[c], Saemah Rahman[c] ,Khairiyah Mohd Yusof[b] Nor Kamariah Noordin[a] , Mohd. Saleh Jaafar[a]

[a]*Universiti Putra Malaysia,Serdang, Selangor, Malaysia*
[b]*Universiti Teknologi Malaysia, Skudai, Johor Bahru, Johore, Malaysia*
[c]*Universiti Kebangsaan Malaysia, Bangi, Selangor,Malaysia*

Abstract

Graduates are expected to be well-rounded individuals with the right attitude, knowledge and skills. The traditional teacher-centred approach may not be effective in ensuring the achievement of well-rounded graduates as expected by employers. A more flexible and constructive student-centred approach such as Project Oriented Problem Based Learning (POPBL) can be an alternative. POPBL has been claimed to have numerous benefits ranging from a more motivated self-directed learner to the acquisition of lifelong learning skills in problems solving and the process that go with it. However, there are challenges and issues facing those who are implementing POPBL. Hence, this study is aimed at examining the practices of POPBL employed by lecturers in Malaysia HEls and to identify factors that affect its implementation.

Keywords: Lecturers perception, Project Oriented Problem Based Learning

1. Introduction

Nowadays, Higher Education Institutions (HEIs) worldwide are facing the demand and challenges to produce competitive graduates who are flexible and able to adapt, apply and transfer their knowledge in the increasingly complex working environment. HEIs in Malaysia are no exception to produce competent graduates as expected by the potential employers . Malaysian government has taken an initiative by having a special plan called National Higher Education Action Plan (2007 – 2010) launched in August 2007 which aims for holistic human capital development. It is to ensure that Malaysian graduates are well-rounded individuals with appreciation for humanistic pursuits. They should have the appropriate skills needed which are critical and crucial in today's globalized and competitive world. Hence, all programmes offered by HEIs must be reviewed and should be in compliance with Malaysian Qualification Framework (MQF) based on the following principles:

- Current contents offered must be benchmarked against nationally agreed criteria and standards in line with international best practices; and
- Incorporation of domains as stipulated in the MQF that include soft skills, such as positive work ethics, communications, teamwork, and decision making and leadership skills.

The traditional teacher-centred approach may not be effective to ensure that the graduates will acquire the soft skills as listed above. Project Oriented Problem Based Learning (POPBL) which is claimed to have numerous benefits ranging from a more motivated self-directed learner to the acquisition of lifelong learning skills in problems solving and the process that go with it can be an alternative. However, there are challenges and issues facing those who implemented POPBL. Hence, this exploratory study is aimed at examining the extent of POPBL implementation among lecturers in Malaysia's HEIs and to identify factors that affect its implementation.

2. Research Objectives

The objectives of this research are:

- To find out the current implementation of POPBL among lecturers in HEIs
- To identify issues and concerns which had arisen in implementing POPBL in Malaysian HEIs
- To identify the current needs for the effective implementation of POPBL

3. Literature Review

POPBL has been proven and agreed by many as a right learning method to improve learning and making the students to be more innovative and creative. Aalborg University, Denmark has been successfully implementing it for more than 30 years. Huang adopted project-based learning method to promote strong collaboration among students. Nielsen et al examined how engineering students had developed process skills in an ICT-based, intercultural and interdisciplinary Project Based Learning environment through a student satellite project. With the students' involvement in innovative projects, the author claimed that students will be able to create a new knowledge. Tongsakul et al conducted a study in Thailand to examine instructors' perceptions on factors that empower students in Project Based Learning. The order of importance as perceived by instructors' were thinking skills, intelligent awareness, sharing ideas, motivation to learn and scientific process.

Despite the advantages of POPBL as discussed above, Borch et al claimed that many institutions did not adopt the method due to the following three reasons: Firstly, reluctance of the staff to change to a new method to replace the existing method. Secondly, concern among staff to lose influence, control and respect. Finally, the organizations' and staffs' concern on students competence measurement. Borch et al also found that it would remain a challenge for students with different educational backgrounds, practical experience and ethnic backgrounds to coordinate their knowledge, thinking and activities. Other challenges identified by other researchers include lack of institutional support, students teamwork and communication skills, and finally, assessment issues and quality control mechanism. Tongsakul et al reported that challenges faced by the instructors were creating the appropriate classroom conditions and atmosphere necessary for project-based learning activities.

Based on these considerations, Moesby suggested a process change model for curriculum development with equal emphasis on personal skills and abilities and technical competencies. It involved incorporating these transferable skills and life-long learning abilities into the curriculum in the earlier semesters of the program.

4. Methodology

This study used quantitative methods to examine the current practice of implementing POPBL among HEI's academicians The academicians are categorized into four groups namely government HEIs, private HEIs, Community Colleges and Polytechnics. 122 academicians are given the questionnaire. It consists of three parts. Part A is related to the demography of the respondents and also questions related to their understanding of POPBL and their current implementation of POPBL. Questions in Part B are about lecturers' perception of POPBL while Part C questions asked on the skills that are required or to be enhanced for effective implementation of POPBL.

4.1. Background Information

The demographic data collected included types of institutions, gender, teaching experience, highest academic qualifications and field of specializations. The highest respondents comes from the college community (43%), followed by Government HEI (30%), Polytechnic (14%) and Private HEI (13%). A total of 48 females and 74 males participated in this survey. The participants comes from various fields of specialization with the majority are in the engineering, manufacturing, and construction field. Out of 122 correspondents, 35 are in this group with the least in the agriculture and veterinary sector (1 correspondent).

5. Findings

The key findings of this study pertaining to lecturers understanding of POPBL characteristics, the issues and current implementation of POPBL among lecturers, lecturers perception of POPBL and skills which they think are needed to be enhanced in order for successful implementation of POPBL. Each of these areas will be discussed in the following sections.

5.1. Lecturers understanding of POPBL

A list of POPBL characteristics are being given where the respondents are asked to tick which of the listed items they think are POPBL characteristics. Figure 1 shows the number of responds to each of the listed items. None of the items given, are ticked by all of the respondents. Hence, it can be inferred that, the respondents do not really know the characteristics of POPBL.

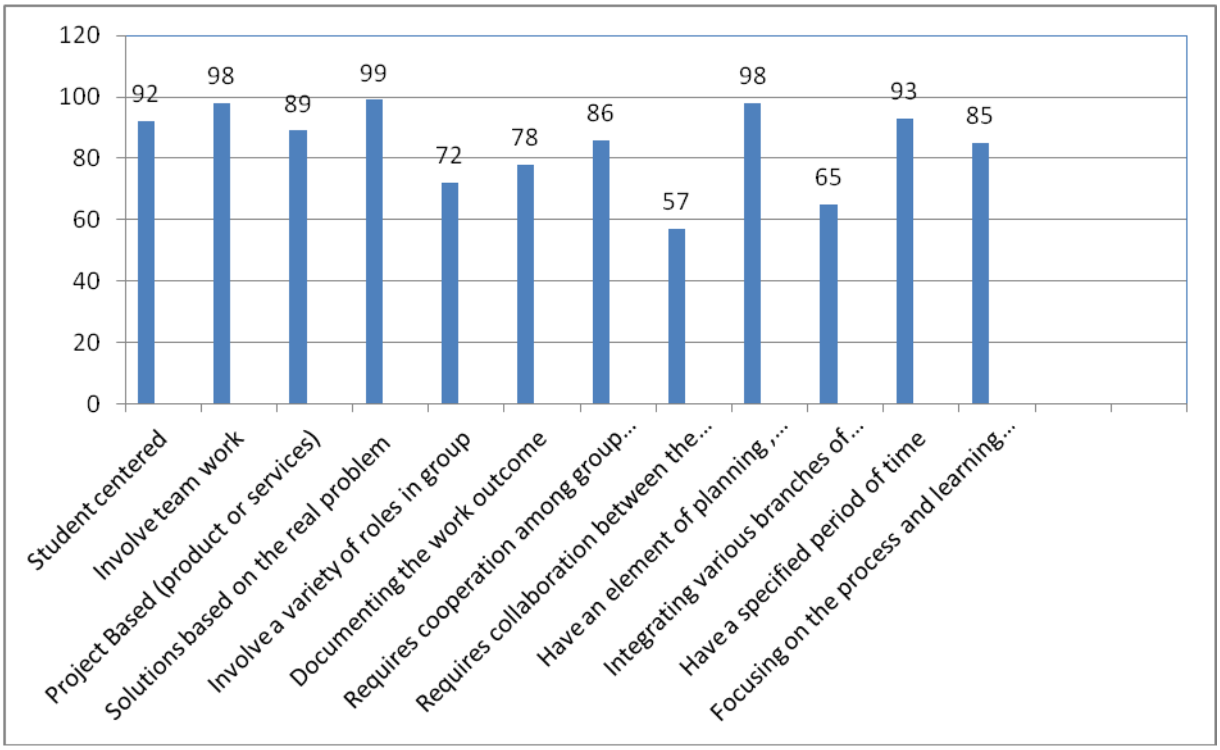

Figure 1. Lecturers understanding of POPBL

5.2 Issues and current implementation of POPBL

The statistic from the survey shows, only 12 had a formal training, out of 122 respondents. The formal training attended by 9 out of the 12 respondent is at their own respective institution while the other three respondents had the training at other local institutions. However, it is interesting to note that, 71 respondents implemented POPBL as their teaching method. This is seen as a good indicator as the lecturers are willing to try new methods. Proactively, they experiment by implementing POPBL although they never had any formal training. However, according to Moesby that in order to successfully implement POPBL, lecturers need to be well equipped with the necessary trainings and motivation. He also suggested that the training should be executed by having training sessions continuously rather than having a major training workshop before the academicians start implementing any new educational model.

Lecturers were also being asked to tick any of the eight listed problems they faced when implementing POPBL. The breakdown of the possible problems to implement POPBL is as depicted in Table 1. It shows that the main challenge the lecturers have is dealing with students' attitude where 66 academicians responded that the students were too independent, 55 respondents said that the students were not proactive while 46 respondents ticked students with no motivation. It is recommended by Moesby that for POPBL to have the curriculum designed in such a way the soft skills are obtained at the early stages of their studies. If these are not overcome, the objectives of the POPBL could fail.

Table 1. Possible problems in implementing POPBL

	Number of respondents
Students who are dependent on the lecturer	66
Students are not proactive	52
Demotivated students	46
Students who are not creative and innovative	42
Lack of mentors	39
It is difficult to change the paradigm of lecturers to the more innovative of Learning and Teaching	31
Lack of space for small group activities	18

Respondents who did not conduct POPBL in their courses were also being asked to tick a given list of reasons of not implementing POPBL. Table 1 shows the responses to each of the questions asked.

Table 2: Factors POPBL is not implemented

Why POPBL is not implmented	Total
I'm not sure how POPBL can be implemented in my courses	32
No emphasis on the use of POPBL at my institution	22
No Knowledge	20
Difficulties in implementing POPBL in my courses	15
Not suitable for my course	15
Other	2

From Table 2 above, it shows that 32 respondents out of 51 did not know how exactly to implement POPBL and 20 had no knowledge of POPBL. These results emphasize that training is necessary to facilitate the lecturers in implementing POPBL.

5.2. Lecturers' perception on POPBL

Part B of the questionnaire is to get the lecturers' perceptions on POPBL Table 3 below shows the lecturers' perceptions means and standard deviation for the survey questions. The lecturers' responses on the question as (1) Strongly not agree and (5) Strongly agree. The mean for each statement is more than 4 with standard deviation less than 1. The respondents agreed most strongly (M=4.51) that through POPBL, students work in team. The lowest mean as indicated by the respondents is on the item POPBL enable students to learn about research ethics (M=4.03). Hence, we can conclude that the respondents agree that POPBL will be able to train students to be leaders, working in a team, and capable of problems solving, critically and creatively.

Table 3. Lecturers perception on POPBL

	Mean	SD
POPBL train students to become leaders	4.19	0.75
POPBL enable students to enhance their ability to interact	4.44	0.6
Through POPBL, students work in team	4.51	0.61
POPBL train students to solve problems critically and creatively	4.45	0.6
POPBL enable students to learn about research ethics	4.03	0.70
Students are able to understand more content of the course through POPBL	4.05	0.79
I believe POPBL can be applied in my field	4.17	0.83

5.4 Skills which are required to be enhanced

Part C of the survey asked the respondents to rate the skills that they think that are required to be enhanced for effective implementation of POPBL. The responses on the question as (1) Strongly not needed and (5) Strongly needed. Table 4 below shows the mean and standard deviation of the skills that respondents think that need to be enhanced. The highest mean (M=4.19) indicated by the respondents is on Monitoring and Evaluation of Learning Outcomes while monitoring of large group has the lowest mean (M=3.78). Since the mean for each of the items is more than 3, it can be concluded that respondents think that all the skills listed are needed to be enhanced.

Table 4. Skills that are required or to be enhanced

	Mean	SD
Problem formation	4.10	0.74
Monitoring of large groups	3.78	0.83
Project supervision	4.13	0.59
Motivating Students	4.18	0.72
Monitoring and Evaluation of Learning Outcomes	4.19	0.62
Integration of ICT in the POPBL implementation	4.02	0.8

Analyzing the findings of this study, skills that are required or to be enhanced are identified by the order of importance are as follows: 1) monitoring and evaluation of learning Outcomes 2) Motivating students, 3) Project supervision 4) problem formulation 5) Integrating of ICT in the POPBL implementation and finally monitoring of large group.

6. Conclusions

This paper presents the findings of a survey conducted among 122 lecturers from Higher Educational Institutions (HEI) in Malaysia, The objectives of the survey are to (1) find out the current implementation of POPBL (2) identify issues and concerns which had arisen in implementing POPBL and (3) identify the current needs for the effective implementation of POPBL.

The results show that 58% of the respondents implement POPBL as one of their teaching methods. However, only 12 respondents had a formal training on implementation of POPBL. The main challenge the lecturers have is dealing with students' attitude where 66 academicians responded that the students were too independent. As for the need for effective implementation of POPBL, the respondents identify monitoring and evaluation of learning outcomes as the most required skill to enhance.

In conclusion, lecturers realized the importance of implementing POPBL for the students to enquire the soft skills on top of getting the technical knowledge. Additionally, this study shows most lecturers think that they need training for the necessary skills for effective implementation of POPBL such as problem formation, assessment, and also supervision. The lecturers are also having difficulty in dealing with students attitudes when implementing POPBL.

Our findings also suggest that lecturers are willing to experiment new method of teaching although they did not undergo any formal training.

7. Limitations of the study

Due to the limited time and financial resources available, the survey is of limited scale and scope. Only 122 respondents are being asked to answer the survey questions. Hence, the results may not be fully representative of the views of the Malaysia HEIs' lecturers. However, the study is adequately useful in gaining understanding of the issues and current implementation of POPBL and lecturers perception of POPBL. This survey will be repeated where on-line questionnaires will be sent to more respondents in the near future.

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References

National Higher Education Action Plan 2007-2010. http://www.mohe.gov.my/transformasi/images/2_bi.pdf

Malaysian Qualification framework-MQA. www.mqa.gov.my/.../MALAYSIAN%20QUALIFICATIONS%20FRAME...

Roger Bennette(2001). Lecturers' Attitudes towards New Teaching Methods, *The International Journal of Management Education* Vol. 2 No. 1 pp 42-59.

Egon Moesby(2005). Curriculum Development for Project-Oriented and Problem Based Learning(POPBL) with Emphasis on Personal Skills and Abilities. *Global J. of Engineering Education* Vol. 9 No. 2 pp 121-128.

E.M.Borch, Jan Helbo and PerPritz(2007). Changes in Roles and Behavior of learners and teachers when for POPBL. *Proceedings of the sixth conference on IASTED International Conference Web-Based Education*, Vol. 2, pg 92-97.

Huang Jun(2010) "Improving Undergraduates' Teamwork Skills By Adapting Project-based Learning Methodology" *Proceedings of the IEEE International Conference onComputer Science & Education* , pp 652-655

J.B. Nielsen, X.Y.Du and A Kolmos(2010). Innovative application of a new PBL model to interdisciplinary and intercultural projects. *International Journal of Electrical Engineering Education*, Vol 47, pp 174-188

Anuvat Tongsakul, Kalayanee Jitgarun, Weerachai Chaokumnerd(2011). Empowering students through project-based learning : Perceptions of Instructors and students in vocational education institutes in Thailand. *Journal of College Teaching & Learning*, Vol. 8, No. 12 PP 19-34

Implementation of Problem Based Learning in Higher Education Institutions and Its Impact on Students' Learning

Johari Surif [a *], Nor Hasniza Ibrahim [b] and Mahani Mokhtar [c]

[a,b,c] *Dr, Faculty of Education, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia*

Abstract

Problem-based learning is a teaching strategy which emphasizes active learning. This study aims to identify the strategies and the effect of PBL in teaching and learning in higher education institutions. In addition, the study also aims to identify the level of students' satisfaction towards the use of PBL in their learning. This study combines quantitative and qualitative methods with descriptive design. The instrument consists of a set of questionnaires and semi-structured interviews. The questionnaire was administered to 226 undergraduates in an institution of higher education who were chosen randomly. Interview sessions were carried out on eight selected respondents. Quantitative data were analyzed using descriptive statistics while content analysis was adopted to analyse qualitative data. The results show that students were able to solve the problems presented using lecture approach, group activities, lecturer guidance and independent learning. The findings also show PBM could enhance soft skills particularly on students' motivation, communication skills, collaboration and independent learning. Students also found to have positive perceptions towards the implementation of PBL in their learning process. In conclusion, PBL is a teaching strategy that needs to be applied in the process of learning in higher institutions towards the development of students who are brilliant and skilled.

Keywords: Problem Based Learning. Higher Education, Teaching and Learning, Teaching Strategies;

1. Introduction

Problem Based Learning (PBL) was first introduced in the world of education in the 1960's by Professor Dr. Howard Barrows at McMaster University, Canada in the medical field (Hung, et al, 2009; Norhaslini, 2011). It was then expanded to other medical schools around the world, such as Michigan State University in the United States, Maastricht University in the Netherlands, and Newcastle University in Australia (Barrows (1996) in Hung, et al, (2009). Consequently, PBL is then expanded in other fields such as engineering, economics, science, language, history and education. Currently, problem-based learning approach and the use of real cases or PBL has been one of the very popular curriculum innovations in education. It is because this approach encourages students to be transparent, flexible, having diversified ways of thinking and is considered as a paradigm of multidisciplinary studies. It also integrates learning content with real-life applications through the context of a particular problem or. Accordingly, PBL has become a major focus of education researchers in the development of civilization in the 21st century.

Problem Based Learning (PBL) is a learning method which uses 'real problem' as a trigger in problem solving. Through PBL, students actively identify learning needs with the help of facilitators. Barrows and Tamblyn (1980) defines PBL as a direct result of the learning process to understand or solve a problem. Problem discovery is the first step in the PBL learning process. This problem serves as a boost and by focusing on the use of problem-solving skills and reasoning, students are encouraged to find new information and organize existing knowledge. Consequently, the problem is finally resolved.

Tan (2003) states that PBL design focuses on first solving problems presented to students. The second aspect is seen in terms of the role, expertise and guidance of a facilitator. Moreover, if viewed in terms of the students' role, the main focus is the involvement of students which shift from being passive to actively solve a given problem. According to Graaff and Kolmos (2003), PBL education strategy can solve problems during learning process. Goodman (2010) also supported the idea by stating that (2010) through the use of problems in PBL, students are motivated to learn concepts and ideas. Usually the problems starting from the day-to-day issues and customized based on the objectives and criteria of education. The process of learning using problems can be summarized as Figure 1.

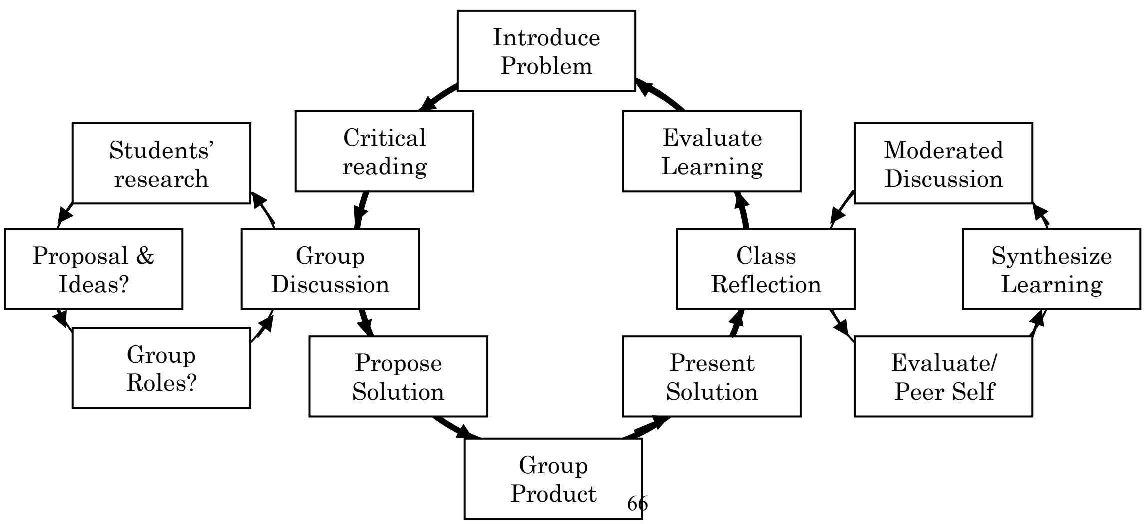

Figure 1. Problem Based Learning Process

Based on Figure 1, PBL process starts by submitting critical reading and identifying problem and then followed by a group discussion. In groups, students conduct research; formulate ideas in groups until reaching proposed settlement. Through process improvement, outcome is presented in class and discussed. Assessment is carried out in the class, followed by group learning and discussion of the proposed conclusion. Finally assessments are done either through implementation of successful problem solving goals. In other words, PBL is an inductive learning methods, namely the learning of specific things that lead to more general (Goodman, 2010). Now, PBL is ranked as one of the alternative strategies in teaching either at school or higher education institutions.

1.1 Problem Based Learning in Higher Education Institutions

Perspectives on learning in higher education (HE) involve the implementation of a curriculum that is abstract and requires high level thinking skills. Knowledge in HE needs to be delivered until the facts can be applied to a related situation (Wood, 1997). Thus, the activity of critical and creative thinking should be found in every university course in order to ensure the application of knowledge. However, a study showed that the application of higher-order thinking is very limited as most of teaching and learning methods in HE using lectures (Lyle et al (2001).

Lectures are based on the theory of deductive approach that considers learning as a process of knowledge transfer from a lecturer to students. Students will gain only the validity and accuracy of information presented without the need to think more about it. In fact, learning is defined as permanent changes in human behaviour due to interaction with the environment. Learning is a change in an individual as a result of experience. People began to learn since they were born, and learning is related to experience (Slavin, 2005). These changes occur in cognitive structure established by the process of assimilation and accommodation as a result of the interaction between a person and the environment (Hill, 2002).

Class activities which require students to listen passively and recall information will not promote critical thinking (King and Kichener, 1994). As a result, institutions of higher learning cannot produce graduates who possess high level of thinking and fail to meet the criteria set by their potential employers. Courses in higher education should employ appropriate teaching and learning approach. The approach should utilize the basics of high-level thinking and enable students to manipulate information and ideas. Consequently, it can encourage students to find meaning and implications when they attempt to connect between facts and ideas.

In order to achieve this purpose, PBL is considered as one of the strategic ways to improve higher-order thinking. The implementation of PBL involves teaching through problem solving in groups on real life situations which require students to think critically to solve given problems. PBL nature of the research process is able to guide students to learn the concepts or content effectively. PBL conclusion is needed to ensure future graduates have life-long learning skills. In addition, PBL produces graduates who have the skills to solve problems and also possess analytical and critical thinking. In addition, PBL graduates will be able to integrate knowledge and skills in various disciplines, acquire soft skills and able to work in teams.

1.2 Importance of PBL to Improve Soft Skills Among Students

Communication Skills

Students had indicated in a study that good communication and interaction between groups of friends is the most important factor that can promote their learning in PBL. Interaction with a group of friends is important in PBL because students have to turn and share information while they try to solve a given problem. So indirectly PBM can implement and enhance good communication skills among students. This is supported by Barrows and Tamblyn (1980) which states one of the main objectives in PBL is that students will be able to enhance their communication skills.

Cooperation Group

According to Wee (2004), to be a student and a skilled workforce, a person needs to have strong communication skills and decision-making skills are also necessary in order to be a competent workforce. What is certain every student should have an outstanding achievement in whatever endeavor. The study also found that atmosphere in PBL group discussion which encourages collaboration can also influence students interest in PBL. Furthermore, findings in a study showed 79% of students agreed that activities which promote discussion enhance their interest in PBL (Drawn Norbaizura, 2009; Gibbon and Wall, 2000). A study by A. Nafis (1999) highlighted that students agreed that the atmosphere in group discussion and the act of collaboration influenced their academic performance. Consequently, the students earned grade point average from 3.50 until 4.00.

Similarly, in a study that was conducted by Mpofu et al (1998), 27 students preferred to work in groups since it can affect their learning. According to Wee (2004), excellent individuals can improve and overcome any weaknesses. Influence on individual and group is certainly one of the elements found in PBL process. If students work in teams, it will be easier to solve problems than working individually. Thus, the students will be more brilliant and mature as compared to those who go through traditional mode of learning.

Self Learning Skills

Norbaizura (2006), found that respondents agreed that one of the advantages of PBL is that it can promote self-learning skills in them. This was supported by A. Nafis (1999) who obtained a similar result. According to Wee (2004), the objectives and advantages of PBL are promoting independent learning skills. Through management of a given problem, students are responsible for their own learning. Linking existing knowledge as the first step to manage the problem, students will know their limits and what is needed for learning. They will learn to find, evaluate and synthesize new learning from a variety of credible sources, including books, journals, magazines, internet, qualified advisors, facilitators and experts in related fields.

Independent learning is relevant to be adopted by students because it will yield effective results. Students will be able to update their learning and skills effectively and efficiently. As a result, students are able to cope with new challenges that lie ahead, especially in the future working environment. In addition, other advantages of PBL is that they can learn something new through past mistakes as PBL is not a linear process (Wee, 2004). Existing processes in PBL allow students to obtain relevant information and relate the information obtained with the existing information. They also will discuss and debate the information. In addition, they will also identify whether the knowledge gained is adequate or not to solve a given problem. Students are also encouraged to reflect and always ready to solve new problems.

Perception refers to the views of students on several aspects of Problem Based Learning (PBL). Siti Norbaizura (2006) conducted a study to examine students' perception on PBL. Majority of students felt that PBL encouraged them to learn independently. A study conducted by Gibbon and Wall (2000) found that 75% of students agreed that PBL increased their motivation to learn. This is because, self-study creates independent students. Students are able to pursue knowledge independently especially in terms of acquiring information technology skills which can assist them in understanding topics of study.

According to Rogers (1994) in Mok (2003) self-study is equal to the change and growth of a person since naturally all people have the desire to learn. During self-study, lecturers can only act as facilitators, who perform tasks such as building positive learning environment and explain the purpose of learning, compile and build the source of information. In addition, facilitators also serve to balance between intelligence and emotional components as well as share their feelings and the views of students. Besides this, students felt that PBL encouraged them to learn continuously. This notion was found in a study by A. Nafis (1999). This effort is vital to the government's mission to promote lifelong learning culture among its citizens.

Critical and Creative Thinking Skills

In addition to the above points, the study conducted by Siti Norbaizura (2006) showed that students felt that they needed to apply their Critical and Creative Thinking Skills (CCTS) in order to solve the problems in PBL. According to Mok (2003), critical thinking is defined as the use of operational thinking which forms the basis for analysing. The operational use of thought is interpreted as the basis to analyze, interpret and evaluate an argument. Poh (2000) stated that critical thinking skills can be divided into two smaller components namely; analyse ideas and analyse arguments. Analysing and comparing ideas include the ability to distinguish, classify, and examine the relationship between overall ideas or sequence. Analysing arguments include finding causes and conclusions or make assumptions. Assessing skills are also divided into two sub-components namely; evaluating information and assessing the reliability of information. Making analogies and conditional reasoning also includes assessing element inference. It is clear that all the components of thinking skills can be generated through the use of PBL in teaching and learning. This is because all of the components of such skills are needed during a given solution.

PBL has the potential to enhance the effectiveness of teaching and learning, particularly in developing higher-order thinking skills and promoting soft skills among students. However, the question lies in the strategy of PBL implementation and the impact of the implementation in the process of teaching and learning in higher education institutions. What about the level of student satisfaction towards teaching and learning using PBL approach? Therefore, a study was carried out in higher education institutions to:

1. Identify the implementation of Problem Based Learning in the process of teaching and learning in UTM.
2. Describe the effect of the implementation of Problem Based Learning in teaching and learning in UTM.
3. Identify the level of students' satisfaction towards teaching and learning using Problem-based learning approach.

2. Research Methodology

This study uses quantitative and qualitative methods with descriptive design. Descriptive explanations explain the phenomenon while the quantitative method was supported by interviews to strengthen the findings. The study population consisted of 226 students from an institution of higher education who were chosen randomly. Data were obtained using questionnaires and interview questions. A set of questionnaire with 31 items examined strategy, impact and level of students' satisfaction towards the teaching and learning process using problem-based learning approach. Five-point Likert scale was used for the collection of information. Data were analysed using Statistical Package for Social Science (SPSS 17.0) to obtain mean value. Interviews were conducted on 15 selected undergraduates. Pre-recorded interview data were transcribed and analyzed using content analysis techniques.

3. Results and Discussion of Study

3.1 Problem Based Learning Implementation Strategy

Table 1. Strategy implementation of PBL in higher education institutions

No.	Some of your subjects will be taught using problem-based learning (PBL) approach. At this stage, how often do you think you will be doing the following activities in the PBL subjects?	1	2	3	4	5	MEAN
1	Attend lectures using PBL	0	9	17	130	70	4.15
2	Work in a PBL group led by a teacher	0	0	9	130	87	4.35
3	Work in unsupervised PBL groups	0	43	52	87	43	3.58
4	Find resources on-line/library to solve problems in PBL	0	17	26	122	61	4.00
5	Write PBL individual reports	0	17	87	122	0	3.46
6	Write PBL group reports	0	0	26	148	52	4.12
7	Work in a PBL laboratory/workshop	0	0	26	130	70	4.19
8	Sit exams and tests in PBL courses	0	17	52	122	35	3.77
9	Give presentations in PBL class	0	0	9	174	43	4.15

(1=never, 2 =rare, 3= sometimes, 4=often, 5=always)

Collaboration lectures and group activities based on problem

The results showed that the PBL sessions were dominated by lecture sessions (mean = 4.15) as well as group work (mean = 4.35). Regular lecture activities were implemented as university lecturers and students were expected to accomplish the credits based on the courses taken. Lecture activities were also implemented to provide a brief guide of the problem presented and the concepts to be learned by students. However, lectures were no longer dominated by a strategy of chalk-and-talk only. Instead lecture activities became the medium for lecturers and students to submit problems to be solved in group activities. This is further described by the following interview transcript:

Students: We present the lecture session ... lecturer will explain the problems we need to solve ... lecturers also guide us in group discussions on strategies to solve the problem, such as what the important issues that should be known and the information should be sought ...

Active learning

The results also show that students were given active roles in problem-based learning such as learning in groups (mean = 4.35):

Researcher: Describe the activities undertaken during the implementation of PBL.
Students: We were divided into small groups ... I have a group of 4 and 5 ... then we were asked to discuss ... appointed as leaders, loggers, and search information ... during the discussion, faculty members will come and ask for the issue and the information we have obtained ...

The transcript indicates PBL implementation based on active learning in groups. This is in line with Zaleha and Daliyanie, (2011) who suggest that PBL is a method implemented in collaborative learning, where students will not be given content. Thus students are encouraged to play an active role during the learning process in order to obtain information and knowledge to solve problems. Zaleha and Daliyanie (2011) also add that students often find their own information related to the problem presented in Problem Based Learning.

Guidance to students

The findings also indicated that there existed process guidance to students and monitoring processes particularly in group activities. The majority of students stated that they sometimes were asked to work without a guided group (3:58).

Researcher: Did lecturers provide guidance?
Student: There is ... time in the group, particularly, the lecturer asked us to list the issues that have been known, not known and need to know...
Researcher: What happened in large lecture?
Student: Lecturer gives a lot of motivation and strategy to solve the problem in an orderly fashion..
Researcher: Did you need coaching from lecturers?
Student: Yes ... We do not know if there a way to start ... do not know the right way to solve the problem...

This shows that students still need help and guidance from lecturers when accomplishing group assignments. Lecturers play important role in the success of group discussions. Zaleha and Daliyanie (2011) support the issue when they said that students still need guidance and attention while conducting PBL. Teachers are important in promoting and guiding students' participation in PBL activity.

3.2 The Effect of Applying The Problem Based Learning Among UTM Students

This study focused on the effect of the implementation of problem-based learning discussion on motivation, self-learning, collaborative and communication skills. The data are shown as Table 2.

Table 2. Effect of PBL among students

No.	Motivation in PBL Class	1	2	3	4	5	Mean
1	I am studying with full of interest during PBL class.	0	9	35	104	78	4.12
2	I enjoy learning chemistry because of the use of PBL approach.	0	9	52	113	43	3.88
3	University learning environment raise my interest and motivation in learning in PBL.	0	0	26	148	52	4.12
	Self Directed Learning (SDL in PBL Class	**1**	**2**	**3**	**4**	**5**	**Mean**
1	I learn a lot by reading books in PBL class.	0	35	35	139	17	3.62
2	I am finding information in the library during PBL.	0	35	70	122	0	3.38
3	I am finding information on the internet during PBL.	0	0	17	139	70	4.23
4	I manage my time effectively during PBL.	0	9	87	122	9	3.58
5	I can identify my learning goals without depending on my supervisor during PBL.	0	52	52	122	0	3.31
6	I take responsibility for my own learning during PBL.	0	17	43	122	43	3.85
	Collaborative skills in PBL Class	**1**	**2**	**3**	**4**	**5**	**Mean**
1	I am working well in a PBL team with other people.	0	9	26	104	87	4.19
2	Working as a PBL team helped me in learning academic content	0	0	26	104	96	4.31
	Communication skills in PBL Class	**1**	**2**	**3**	**4**	**5**	**Mean**
1	I am good at writing reports/ essays in PBL class.	0	0	113	113	0	3.50
2	I speak well in front of a group in PBL class.	0	0	35	156	35	4.00

(1=totally not agree, 2 =not agree, 3= neutral, 4=agree, 5=strongly agree)

Increase student motivation

The survey indicated that majority of students were motivated to learn chemistry using PBL. It also helped to increase intrinsic motivation, and built skills for higher knowledge. Majority of students (mean = 4.12) believed that learning environment was the primary influence in increasing students' interest and motivation to learn through problem-based learning (PBL).

Researcher: Is PBL increase motivation?
Student A: Yes ... cause we are more prepared ... its fun when we can solve a problem...

The findings support previous results which show PBL gave positive results in students' motivation or attitude towards science courses (Diggs, 1997, Ram, 1999; Senocak, Taskesenligil & Sozbilir, 2007; Tarhan & Acar, 2007; Rajab, 2007; Serin, 2009; Kelly & Finlayson, 2009). However some respondents denied that they were motivated to learn because of PBL.

Researcher: Does PBL increase your motivation?
Student B: I do not know ... I think PBL is more difficult ... there are so many things to do ... we have to find our own information ... we have so many assignment ...

The transcript shows that most students were burdened with PBL implementation that somehow reduced their motivation. Similarly, a number of previous studies indicate that PBL does not affect motivation (Kocakoglu, 2008). It was also acknowledged by Sungur (2004) that PBL does not have a positive impact on students' exam anxiety, self-efficacy and belief learning.

Increase self-study

Results of this study also show that PBL can improve independent learning skills. Majority of students can search online reference and information individually without supervision in an effort to solve the problems presented. This self-paced learning is actually able to build inquiry skills and curiosity among students thus creating a level of confidence and believe in them. Furthermore, most students agreed that PBL able to cultivate the skills to find information in the library, create efficient time management, set a goal to learn on their own and be responsible for learning (mean = 3.38). The results also show students are more likely to get information from internet sources than search for information in the library (mean = 4.23). Internet access facilities at institutions of higher learning in addition to the many resources that are available to solve the problem.

Researcher: Does PBL help independent learning?
Student: Yes.
Researcher: Can you explain more?
Students: We have to find own information ... mostly we get on the internet ... no part of the book, looking at the library or borrow books lecturers ... he he ...
Researcher: What about time management?
Students: We manage time ... a lot of time running out in the discussion ... make notes and presentations ...we must know how to solve the problem...

This finding is in line with the statement by Zimmerman & Schunk (2001) who claim that self-learning strategy is decisive for the achievement of quality learning.

Enhance group learning

More than 20 respondents believed that enhancing collaborative skills are also an effect of PBL. Students prefer to work in groups because it can help students to learn academic content better. Lynda and Megan (2002) states that through group learning, a variety of skills can be formed It is also supported by Murray, Curtis, Cattley and Slee (2004) who state that PBL process give ample room for students to develop collaborative skills . Cooperation which existed in collaborative skills form positive student behavior and draw their attention to learn.

Communication skills

According to Stefl-Mabry and Powers (2005), the view from one of their respondents was that collaborative learning is the key to communication. Communication is a skill that is important for the student to share ideas and form new ideas. It helps to correlate existing knowledge with new knowledge. Communication is not limited to words. Ideas and concepts presented in visual presentations also show the importance of communication. Communication skills are not only in terms of skills in writing reports (mean = 3.50), but also verbal communication among students. The findings showed that students were confident when communicating among other partners (mean = 4.00).

Researcher: Does PBL improve communication skills such as writing and speaking?
Student: Yes ... I do individual reports, journal reflection and group reports ... does improve writing...
Researcher: What about verbal communication?
Student: Had to present ... first fear ... but after some time its ok ... have to make a lot of discussion ... PBL improve communication

This finding was also supported by Simranjeet et. al. (2011), who state that PBL encourages students to read the given problem, gather feedback from their friends, find solutions and finally do group presentations. All of these steps require communication skills throughout the PBL process.

3.3 Level of Students' Satisfaction on The İmplementation of Problem Based Learning in UTM

Based on the studies conducted by previous researchers, PBL has been identified as a catalyst to improve students' achievement (Achilles and Hoover, 1996). The study discusses the implementation of PBL in the level of satisfaction among students. Studies show that majority of students gave a positive feedback on the implementation of PBL.

Table 3. Levels of students' satisfaction in the learning process

No.	Satisfactory level in PBL approach	1	2	3	4	5	Mean
1	I learned more in PBL compared to traditional lecture	0	0	26	104	96	4.31
2	I will recommend PBL in other subject	0	0	43	113	70	4.12
3	I will attend another course using PBL	0	0	35	148	43	4.04
4	I like tackling unfamiliar problems in PBL	0	26	87	113	0	3.38
5	In PBL, I have developed many useful strategies to help me in my learning.	0	0	43	174	9	3.85
6	My lecturer gives me regular feedback during PBL on how I am doing with my project.	0	0	52	139	35	3.92
7	I am able to get help from my lecturer whenever I need it during PBL.	0	17	17	130	61	4.04
8	PBL learning environment helps shaping me to be good at thinking critically.	0	0	43	113	70	4.12

(1=totally not agree, 2 =not agree, 3= neutral, 4=agree, 5=strongly agree)

Students positive outlook on PBL

The findings showed that majority students agreed that more things can be learned in PBL as compared to traditional lecture method (mean = 4.31). It is because in PBL, students will not only be exposed to capture content in education, but also must master a variety of thinking skills, especially the ability to think critically and creatively in order to find the right solution to a shared problem (Kenneth and Williams, 2001). Furthermore, majority of students also agreed that PBL is always included in other subjects (mean = 4.12). PBL is an effective method to develop students' thinking process skills because students are exposed to scientific inquiry thinking and are able to develop skills in giving reasoning that require good understanding of content in order to solve problems (Dorothy and Diane, 1986; Kenneth and Williams, 2001). The results also showed that the respondents agreed that they preferred to face and solve problems which were uncommon (mean = 3.38).

Researcher: Are you satisfied using PBL strategies?
Student: Hm ... satisfied. Much can be learned.... More independent ... better understanding compared lecturers teach ordinarily ... Quite challenging ... Worth it although little tired but...

This finding was consistent with a recent study conducted by Keller (1987) who suggested that PBL can be considered as a challenging learning approach. This is also in line with natural human instinct that tends to dominate challenges and obstacles. In addition, learning environment at the university also help students in the development of the diversity of their learning strategies (mean = 3.85). Reasoning process is one important element in PBL. Learning in problem-based learning environment is not as simple as collecting the facts alone. As recommended by Dunlap and Grabinger (1996), abilities and cognitive processes are required for activity in PBL. These activities stimulate higher order thinking skills and can ensure better knowledge transfer in the future.

PBL learning environment also encourages independent learning among students which simultaneously help the students to become good thinkers. Most respondents (mean = 4.12) believed that they were stimulated to be good thinkers as a result of teaching approaches practiced by the lecturers in UTM. In PBL, students have the role to trigger their own learning, asking questions and solving problems during the learning processes. Therefore, they are no longer acting as passive recipients of information. In PBL, students not only need to reassess their roles but they also need to modify their past study habits. Norman and Schmidt (1992) found that undergraduates will be more independent thinkers and more responsible for their own learning and the notion was supported by a study conducted by Jonassen (2006). Researchers in other studies also (Lo, 2004; Martin et al., 1998; Schelton and Smitd, 1998) found that more students were able to integrate theory with actual situations after learning through PBL.

4. Implications of The Study

Studies demonstrate that PBL brings positive impact in increasing students' motivation, self-learning and soft skills. It is because, PBL use learning problems as a catalyst to encourage students to think critically. Group learning activities and leadership roles help to develop students' communication and collaboration skills. Thus, this strategy is suitable for implementation in higher education. However, there were complaints from some students about the challenges they faced in solving problems and mastering the content. Time constraint and multiple tasks that must be completed for each course created these issues. In this case, the lecturer has an important role to motivate students and provide effective guidance to them. Among the guidance can be implemented include:

1. submit a strategy to understand the problems presented using cognitive tools such as table learning issues (what is known, what is not known, what needs to be known). Cognitive tool to focus the student to understand the problem as a whole and realize the task that must be executed to solve the problem effectively.
2. gives a hint (hint) to students in the monitoring process implemented during the lecturer-student meeting as well as providing encouragement and motivation that encourages them to learn to be more active and organized.
3. arrange a meeting schedule and monitor the progress of students from time to time. Use social forums such as e-learning for this purpose as well as group discussion throughout the learning process.

Overall it can be concluded that many students agree with the implementation of PBL in higher education institutions due to its effectiveness in the learning process. Finally, the students are satisfied if problem-based learning continues to be implemented in chemistry education courses, but many of them agree that PBL should be used for all courses in higher education institutions.

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References

Achilles, C. M. & Hoover, S. P. (1996). *Exploring Problem-Based Learning (PBL) in Grades 6-12*. Paper presented at the Annual Meeting of the Mid-South Educational Research Assosiation, Tuscaloosa, AL.

A.Nafis (1999). The PBL Curriculum Reform at Roven, France: "The Student Viewpoint." *Education for Health*. 12(3). 317-327.

Barrows, H.S. & Tamblyn, R.M. (1980). *PBL: An Approach to Medical Education*. New York: Springer Publications.

Burhanuddin Mohd Salleh. (2011). Pembelajaran Berasaskan Masalah. Buletin Perpustakaan Universiti Tun Hussein Onn Malaysia.http://lms.uthm.edu.my.

Cardellini, L. (2006). Fostering creative problem solving in chemistry through group work, *Chemistry Education Research and Practice*, 2006, 7 (2), 131-140.

Commonwealth of Learning (2002). *Module 10: Concepts of Learning*. Vancouver: Commonwealth of Learning.

Dorothy, L. Gabel & Diane M. Bunce. (1986). *Research on Problem Solving: Chemistry*. National Association for Research in Science Teaching.

Dunlap, J. C., & Grabinger, R. S. (1996). Rich environments for active learning in the higher education classroom. In B. G.Wilson (Ed.), *Constructivist learning environments: Case studies in instructional design* (pp. 65–82). Englewood Cliffs, NJ: Educational Technology Publications.

Gibbon, C. & Wall (2000). *The Sonic Project: Students Perception on PBL: A Case Study*. Access on 5 Disember 2012. http://www.uclan.ac.uk/health/nursing/sonic/paper.htm

Goodman, R. J. B. (2010). Problem-Based Learning: Merging of Economics and Mathematics. *Journal of Economic Finance*.34, 477-483.

Graff, E. D dan Kolmos,A. (2003).Characteristics of Problem-Based Learning. *Journal of Engineering Education*.19 (5): 657-662.

Hill, W.F. (2002). *Learning: A Survey of Psychological Interpretation*.7th. Edition: Allyn and Bacon, Boston, MA.

Hung, Woei., Jonassen, David. H., and Liu, Rude. (2009). Problem-Based Learning. In J. M. Spector, M. D.Merril, J. V. Merrienboer & M. P Driscoll. (Ed.). *Handbook of Research on Educational Communications and Technology*. (p. 485-506). London: Lawrence Erlbaum Associates.

Hussain Othman, Abdullah Sulaiman, Mohd Zain Mubarak & Nik Kamal Wan Mohamed (2006). *Pembelajaran Berasaskan Masalah Dalam Bidang Pengajian Kemanusiaan*, Seminar Pembangunan Pelajar Peringkat Kebangsaan 2006.

Jonassen, D.H., (2006). Accomodating Ways of Human Knowledge in the Design of Information and Instructional. *International Journal of Knowledge and Learn*, 2 (3/4), 181-190.

Keller, J. M. (1987). The systematic process of motivational design.*Performance &Instruction*, November/December, 1–8.

Kelly, O. & Finlayson, O. (2009). A hurdle too high? Students' experience of a PBL laboratory module. *Chemistry Education Research and Practice*, 10, 42-52.

King, P. M. & Kitchener, K. S.. (1994*). Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults*. SanFrancisco: Jossey-Bass.
Kocakoglu, M. (2008).The Effect of Problem Based Learning and Motivational Styles on Students' Academic Success and Attitudes Towards Biology Course. *Unpublished Doctoral Dissertation*, Institute of Education Sciences, Gazi University, Ankara.
Lo, A. (2004) Development quality students for the hospitality and tourism industries through problem-based learning. *Conference Proceedings of Hospitality, Tourism and Foodservice Industry in Asia: development, marketing and sustainability*. May 27-29, Phuket.
Lyle, K.S. dan Robinson, W.R. (2001). Teaching Science Problem Solving: An Overview of Experimental Work. *Journal of Chemical Education,*78 (9): 121-132.
Lynda W. K. N. & Megan K. Y. C. (2002).*Authentic Problem-Based Learning*. Singapore: Prentice Hall.
Martin, K. J., Chrispeels, J. H. and D'Emidio-Caton, M. (1998) Exploring the use of PBL for developing collaborative leadership skills. *Journal of School Leadership,* 8, 470- 500.
Mok Soon Sang (2003). *Siri Pendidikan Perguruan. Peperiksaan Penilaian Tahap Kecekapan Skim Perkhidmatan Guru (Pengurusan Pengajaran dalam Pembelajaran).* Subang Jaya: Kumpulan Budiman Sdn. Bhd.
Mpofu P. J. S. (1998). A Review of PBL: Perceptions of Students and Tutors at the United Arab Emirates of Students and Tutors at the United Arab Emirates University, *Education for Health*.11(2), 203-213.
Murray-Harvey, R., Curtis, D. D., Cattley, G. dan Slee, P. T. (2004). *Enhancing Learners' Generic Skills through Problem-Based Learning*. Annual Conference of the AARE International Education Research Conference Melbourne. Australia.
Norman, G. R. and Schmidt, H. G. (1992) The psychological basis of problem-based learning: a review of the evidence. *Academic Medicine* 67, 557-565.
Poh Swee Hiang (2000). *Kemahiran Berfikir Secara Kritis dan Kreatif (KBKK).* Subang Jaya: Kumpulan Budiman Sdn. Bhd.
Rajab A.M. (2007). *The effects of problem-based learning on the self efficacy and attitudes of beginning biology majors*. Ph.D. Thesis, University of California, Los Angeles.
Ram, P. (1999). Problem-based learning in undergraduate education: A sophomore chemistry laboratory. *Journal of Chemical Education*, 76(8), 1122-1126.
Reid, N. (2008). A scientific approach to the teaching of chemistry : What do we know about how students learn in the sciences, and how can we make our teaching match this to maximise performance? *Chemistry Education: Research and Practice*, 9, 51–59.
Senocak, E., Taskesenligil, Y., & Sozbilir, M. (2007).A study on teaching gases to prospective primary science teachers through problem-based learning. *Research in Science Education*, 37, 279-290.
Schelton, J. B. and Smidt, R. F. (1998) Problem-based learning in analytical science undergraduate teaching.*Research in Science and Technological Education* 16, 19-29.
Serin, G. (2009).*The Effect of Problem Based Learning Instruction on 7th Grade Students' Science Achievement, Attitude Toward Science and Scientific Process Skills*. Unpublished Doctoral Dissertation, Middle East Technical University, Ankara
Simranjeet K.J, Kamisah O. &Siti Fatimah M.Y. (2011). Cultivating communication through PBL with ICT.*Research in Procedia Social and Behavioral Sciences*, 15, 1546–1550.
Siti Norbaizura Hj. Awad (2006). Kajian Mengenai Persepsi Pelajar Terhadap Pendekatan 'Problem Based Learning'. Suatu Kajian Tinjauan di Universiti Sains Malaysia, Kubang Kerian, Kelantan. *Tesis Sarjana Muda*. Skudai: Universiti Teknologi Malaysia.
Slavin, R.E. (2005). *Educational Psychology: Theory into Practice*. Englewood Cliff: Prentice Hall Ltd.
Stefl-Mabry J. dan Powers, J. G. (2005).Collaborative, Problem-Based Learning.*Knowledge Quest*.Volume 35, No. 4. Mac/April 2005.
Stieff, M. & Wilensky, U. (2002). Connected Chemistry: Incorporating Interactive Simulations into the Chemistry Classroom, *Journal of Science Education and Technology*, 1-17.
Sungur, S. (2004).The Implemenation of Problem Based Learning in High School Biology Courses. *Unpublished Doctoral Dissertation*, Middle East Technical University, Ankara.
Tan, Oon-Seng. (2003). *Problem-Based Learning Innovation: Using Problems to Power Learning in the 21st Century*. Singapore: Thomson.
Tarhan, L., & Acar, B. (2007).Problem based learning in an eleventh grade chemistry class: factors affecting cell potential. *Research in Science and Techological Education*, 25(3), 351-369.
Wee, K. N. L. (2004). *Jump Start Authentic PBL*. Singapore; Prentice Hall.
Zaharatul Laili Abdul Rahim & Ramlee Mustapha. (2007). Pembelajaran Berasaskan Masalah bagi Subjek Elektronik: Satu Kajian Tindakan di Sekolah Menengah Teknik. Seminar Pendidikan Kejuruteraan dan Alam Bina.
Zaleha Ismail dan Daliyanie Mat Saaid.(2011). Pelaksanaan Pembelajaran Berasaskan Masalah (PBM) dalam Matematik di Peringkat Sekolah Menengah.*Journal of Education Management*, 4 (1-17).
Zimmerman, B.J., & Schunk, D.H. (Eds.). (2001). *Self- regulated learning and academic achievement: Theoretical perspectives* (2nded.). Mahwah, NJ: Erlbaum.
Zoller U., (1993), Are lecture and learning compatible? *Journal of Chemical Education*, 70, 195-197.

Development of Profession Skills through CPBL among First Year Engineering Students

Khairiyah Mohd Yusof [a] *, Aziatul Niza Sadikin[b] , Fatin Aliah Phang [a]

[a]*Centre of Engineering Education, School of Graduate Studies, Universiti Teknologi Malaysia, 81310 Johor, Malaysia*
[b]*Faculty of Chemical Engineering, Universiti Teknologi Malaysia, 81310 Johor, Malaysia*
* *khairiyah@cheme.utm.my*

Abstract

Developing professional skills, such as problem solving, team working and communication skills are crucial for engineering graduates of the 21st Century. Cooperative Problem Based Learning (CPBL), which is the infusion of Cooperative Learning (CL) principles into the Problem-Based Learning (PBL) cycle, had been shown to enhance learning while developing the desired professional skills. This paper describes a qualitative study using reflective journals that showed the development of these skills among 32 first year students as they go through three cycles of CPBL to solve the problem given. Written reflections submitted by students at the end of each CPBL cycle were analyzed using qualitative data analysis technique of Miles & Huberman to determine the skills developed, as students progress through each of the three stages of the problem. The results show that although students initially faced difficulties in developing the skills, progress can be seen as they go through the CPBL cycle in each stage of the problem. At the end of the third stage, students realized that they have managed to attain important skills that are essential as engineers of the future.

Keywords: Problem-based Learning, Professional Skills, Reflective Journals;

1. Background

Various engineering education reports (Duderstadt, 2008; Royal Academy of Engineering, 2007; National Academy of Engineering, 2005) from throughout the world stressed on the need for graduates who are not able to apply their technical knowledge, but also possess professional skills that can help them function well at the work place. These skills include problem solving, teamworking, communication, time management, leadership, etc. While there are possibilities of having additional courses to teach students these skills, the already overloaded engineering curricula leave little space for stand-alone courses to address each professional skill required. In addition, research shows that skill like problem solving must be taught in the context of the profession to be effective (Jonassen, 2006). Thus, it is essential for engineering courses to implement teaching and learning approaches that can help students to learn the content, while at the same time develop crucial professional skills.

For this reason, Cooperative Problem Based Learning (CPBL) was utilized to attain the professional skills outcomes in the Introduction to Engineering course taken by first year Chemical Engineering students in Universiti Teknologi Malaysia. CPBL has been shown to enhance motivation in learning and learning strategies, deep learning, as well as develop team based problem solving skills (Mohd-Yusof et al., 2011b, Syed Helmi et al., 2011, Phang et al., 2012). It is the infusion of Cooperative Learning (CL) principles into the Problem-Based Learning (PBL) cycle to provide crucial support for students through the development of team-based learning skills, that will enable them to successfully undergo a PBL learning environment in a typical course setting. Figure 1 shows the CPBL framework, which is used to guide students through the CPBL cycle step by step as they go through the learning process together. More details about the CPBL framework can be seen in (Mohd-Yusof et al., 2011a).

* Khairiyah Mohd Yusof. Tel.: +06-07-5537776
E-mail address: khairiyah@cheme.utm.my

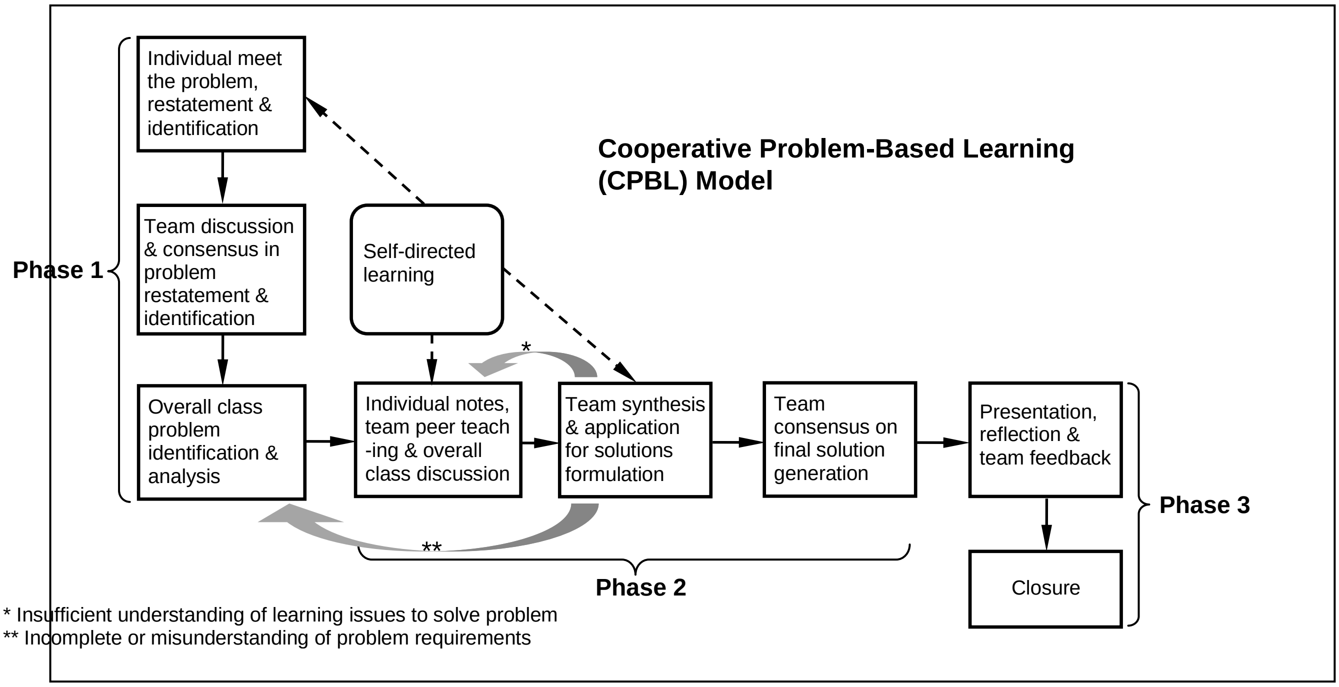

Figure 1. The Cooperative Problem-Based Learning (CPBL) Framework (Mohd-Yusof et al., 2011a)

2. "Introduction to Engineering" Course

The Introduction to Engineering course is a three-credit hour course that is taken by all first year chemical engineering students in Universiti Teknologi Malaysia. The purpose of the Introduction to Engineering course is to bridge the gap between learning in a school environment and learning to be an engineer in the university. Students are put through supportive student centered learning environments that allowed them to develop important skills to learn, as well as understanding and abilities required to be a good engineer when they graduate.

A major component of the course is for students to solve a complex, open ended problem that is related to sustainable development. The problem is set in a real world setting with the involvement of stakeholders. For example, the problem given to students in the 2012/13-1 session was on developing solutions for Low Carbon Society in the Iskandar Region in Johor Bahru, Malaysia. Because of the complexity of the problem, it is divided into three stages, each stage consisting of one CPBL cycle. While an overall problem is given at the beginning of stage Stage 1, problems given in subsequent stages also provide details about further requirements, each with increasing expectation. The problem is designed so that with each subsequent cycle and stage, students are expected to develop and enhance their professional skills. More details about this course can be seen in (Hassim et al., 2013).

3. Research Objective

The objective of this research is to identify the enhancement of professional skills that students develop as they go through CPBL in the Introduction to Engineering course by using reflection journals written at the end of every CPBL cycle.

4. Research Methodology

All 32 students were asked to produce reflective journals after each cycle of CPBL. The first reflective journal was written at Week 6 after the first cycle of CPBL. They were briefed the format of a reflective journal for the purpose of reflecting their learning through CPBL. The next reflective journal was collected on Week 10 after the second cycle of CPBL and then in Week 13. At the end of the semester, the students were asked to write an overall reflective journal to look back at their learning experience throughout the whole semester.

The reflective journals were collected through e-learning, an online learning management system which the students have individual access to their own account. The students submitted their reflective journals through e-learning where the lecturers can access to the submitted documents. For each submission, the lecturers went through the reflective journals to find out problems and issues faced by the students. This helped the lecturers in taking the necessary actions to improve the learning. This is a part of the strengths of CPBL. However, in this paper, the use of reflective journals as a tool for teaching and learning will not be discussed. The focus of the paper is to explain what the students gained in CPBL through the analysis of their reflective journals.

After all the reflective were collected at the end of the semester, a qualitative data analysis technique recommended by Miles & Huberman (1994) was employed. The technique consists of three phases:

data reduction
data display
conclusion drawing and verification

As there were 128 sets of reflective journals from 32 students, the first step of data analysis was to reduce the data in to a manageable volume to answer the research questions. By focusing on the research questions, information that was not important can be put aside. Keywords and phrases that could answer the research questions were highlighted.

In the second step, the data was re-organised using tables. The highlighted keywords and phrases were put into tables based on the generic skills such as team working skills, communication skills, problem solving skills and time management skills. The categorisation was organised for the same students over the different weeks of reflective journals to identify the change that the students experienced.

At the final phase, the categories were re-examined by comparing the slices of data at the second phase to the original full transcripts of reflective journals. This is to ensure that the quotations taken out were not interpreted out of the context. Finally, conclusions were made and they are as shown in the tables in the result section.

5. Results

This paper explores the enhancement of professional skills that students develop in the Introduction to Engineering course, which implemented CPBL. Table 1 shows the four generic professional skills most often mentioned in the students' reflective journals (RJ) that were written at the end of each CPBL cycle. The number given in the table shows the number of students who mentioned the skill in each stage of the different reflection journals.

Table 1. Professional skills found and the number in reflective journals of each stage

Professional Skills	RJ 1	RJ 2	RJ 3
Team Working	7	8	9
Time Management	3	10	6
Communication Skill	7	9	10
Problem Solving Skill	6	6	7

From the skills shown in Table 1, the reflection journal of each stage from one of the students that mentioned the skill was taken to provide a snapshot of his/her perception during the development stage. Table 2 shows some sample quotes for each of the professional skills. For each skill, the vignette written by a specific student for the reflection at the end of Stages 1, 2 and 3 are given to see the student's perception on his or her ability on the skills from the beginning to the end in solving the problem.

At the end of Stage 2, the students' reflection depicted their effort to overcome the initial shortcomings that they had and were beginning to show the development of the skills. Although the students admitted that the tasks at hand were tough, they were expressing more positive remarks, which showed a higher skill level.

At the end of Stage 3, all four students reflected that they have managed to reach a higher level of achievement in the skills after going through the three CPBL cycles to solve the problem given. As seen in Table 2, all of the last vignettes show very positive reflections. All students expressed happiness and confidence, as well as pride in the work that they have done.

6. Discussion

There are four professional skills developed through CPBL by the first year students: team working, communication, problem solving and time management skills. This is similar to the findings of earlier studies conducted on third year students who had undergone CPBL for one semester (Phang et al., 2012, Syed Ahmad Helmi et al., 2011, Mohd-Yusof et al., 2011b). The skills developed are also consistent with other studies on students who had undergone PBL (for developing problem solving skills) and CL (for developing team working skills) (Syed Ahmad Helmi et al., 2011; Strobel and Barneveld, 2009; Prince, 2004; Johnson, Johnson and Smith, 2006). From the reflection journals that have been analyzed, it can be observed that students showed efforts on how they tried to rationalize their situations to cope with new learning style and to make proper planning in solving problem given. Students also showed strong commitment to be an effective team member, developed leadership characteristics and more about the behavioural aspects of effective team working.

The initial difficulties faced by students at the end of Stage 1 of the problem, after undergoing one CPBL cycle is also expected. This is because as explained by Woods (1996), students who are new to PBL will undergo an emotional cycle that is similar to those facing trauma. In the initial stage of the "trauma cycle", most students would be shocked and faced difficulties in trying to cope with a new learning method that required them to use skills that they did not have. Nevertheless, as try to cope and accept that what they have to do is a necessity, students begin to develop the necessary skills as they improve themselves when they go through the CPBL cycle in Stage 2. This is reflected in the more positive outlook in the second reflection journal. At this stage, although they were still struggling, the students could see the fruits of their labour and began to appreciate the skills that they are developing through the learning process. Finally, similar to Woods' description for the end of the "trauma cycle", students reached a higher level of performance when they were able to integrate the new skills that they have developed or enhanced.

Table 2. Example of quotation for skills found at the end of each stage

Professional skills	Reflective journal	Example of quotations from the reflective journals
Team working skills	RJ 1 (S1)	It is really hard for me at first working in a team because I am not a type of person who really likes to work in a group especially in a large number.
	RJ 2 (S1)	It is normal thing in team that we have problems with team members along the project is execute but then as a team we should try to communicate among members and try to overcome all the problem that we face.
	RJ 3 (S1)	But thanks to my team members because this team really change a lot on my perspective when working with a team. They really help me a lot when I need them and motivate me when I needed.
Communication skills	RJ 1 (S2)	Language barrier seems to be main problem which I encountered because our team members came from a various races. There is a little bit awkward to communicate with each other.
	RJ 2 (S2)	This problem required me to think out of box and commit me to make the right decision. Communication barrier are now solved as we always meet for discussion and this make our communication improve from time to time.
	RJ 3 (S2)	It really suits me working in this environment for near future. It's really improve myself confidences well as my communication skills I hope that in years to come, there is a lot of programmed like this so that we can really learn something useful in our university life.
Problem solving skills	RJ 1 (S3)	It is a big pressure for me to handle as it is not a thing that I really familiar with. We have to face the first stage of this PBL that involved a lot of group discussion, completing the report and presentation.
	RJ 2 (S3)	I have to do a lot of research in order to get ideas on how to conserve energy in school. This is very stressful moment for me as the number of tasks to be completed was increased.
	RJ 3 (S3)	Honestly, I am very happy with the report as each of us gives full commitment to complete it. All these work are not easy as abc as each of us need to brainstorm like a half dead person to come out with a good report. However, it taught me to be patient and don't give up even though the challenges are big.
Time management skills	RJ 1 (S4)	We encountered a time problem as we were unable to match with each other timetables. We are realized that lacking of time will responsible to our team failure.
	RJ 2 (S4)	I learned time management by managing my time to do all works I need to do. I also learned not to procrastinate in my works. I did all the works on time in order to spend my time for revisions for the final exam.
	RJ 3 (S4)	PBL was very beneficial for me as a first year student. It had given me lots of exposure about university life. It also helped me to develop my soft skills especially time management which will be useful for me in the future. This kind of problem will equip me to become a better engineer in future.

This finding is also similar to an earlier study on the perception of third year engineering students who had undergone CPBL in a technically intensive course (Phang et al., 2012). In the earlier study, CPBL classroom observations were made throughout the semester, and the third year students were interviewed as the semester progressed to discover their perception as they experienced CPBL. The initial negative perception and frustration of the third year students were very much similar to the reflections made by the first year students. When the students were interviewed in the middle of the semester, evidence of coping and acceptance can be seen, just as the first year students in this study. Finally, at the end of the semester, the feelings of jubilation and success were indeed the same as the first year students after the completing the third and final stage of the CPBL.

The findings of this research shows that first year students who went through the CPBL cycles in their Introduction to Engineering course gained problem solving skills, which is also supported by the study on third year engineering students (Syed Ahmad Helmi et al., 2011). Although this study showed that students faced difficulties and did not develop problem solving skills immediately when they went through CPBL in Stage 1, they realized that they have managed to integrate this skill as they go through the subsequent stages and complete the problem. This shows that the CPBL learning environment is constructively aligned as is desired in its original design, and thus allow students attain this outcome.

7. Conclusion

This study shows that first year engineering students who went through CPBL in the Introduction to Engineering course were able to develop problem solving, team working, communication and time management skills. This is in accordance with previous studies which also showed that there was enhancement of professional skills after going through CPBL. This study also showed that there was a gradual development of the skills as the students go through three cycles of CPBL, which started off with difficulties in facing a new learning environment and negative perception before finally getting comfortable and attaining success.

References

Duderstadt, J.J. (2008). *Engineering for a Changing World: A Roadmap to the Future of Engineering Practice, Research and Education*. The Millennium Project, The University of Michigan.

Hassim, M. H., Kamaruddin, M. J., Jamaluddin, J., Othman, N., Sadikin, A. N., Hashim, H., Hassan, H., and Mohd-Yusof, K., (2013). "An Introductory Course for Instilling Sustainability Awareness: Design and Implementation", PSE Asia 2013, Kuala Lumpur, June 2013.

Johnson, D. W., Johnson, R. T. and Smith, K. A. (2006). *Active Learning: Cooperation in the College Classroom*. Edina, Minnesota: Interact Book Company.

Jonassen, D., Strobel, J, and Lee, C. B. (2006). Everyday Problem Solving in Engineering: Lessons for Engineering Educators. *Journal of Engineering Education*, 95(2) pp 139-151.

Miles, M. B. And Huberman, A. M. (1994). Qualitative Data Analysis (2nd ed.). Thousand Oaks, CA:Sage.

Mohd-Yusof, K., Syed Ahmad Helmi Syed Hassan, Mohammad-Zamry Jamaluddin and Nor Farida Harun (2011a). Cooperative Problem-based Learning: A Practical Model for Typical Course. *International Journal of Emerging Technologies in Learning*, 6(3), pp 12-120.

Mohd-Yusof, K., Syed Ahmad Helmi Syed Hassan, Mohammad-Zamry Jamaluddin and Nor Farida Harun (2011b). “Motivation and Engagement of Learning in the Cooperative Problem-Based Learning (CPBL) Framework”, Proceedings for the 2011 ASEE Annual Conference and Exposition on Engineering Education, Vancouver, Canada, June 26-30.

National Academy of Engineering (2005). *The Engineer of 2020: Visions of engineering in the new century*. Washington: The Academic Press.

Phang, F. A., Mohd-Yusof, K., Fatimah Mohamad Adi and Syed Ahmad Helmi Syed Hassan (2012). " Engineering Students' Perception on Learning through Cooperative Problem-Based Learning (CPBL) for the First Time", Proceedings of the 2012 ASEE Annual Conference, San Antonio, Texas, USA, 11-13 June.

Prince, M. J. (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education*, 93(3), 223-231.

Strobel, J. and van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *The Interdisciplinary Journal of Problem-based Learning*, 3(1), 44-58.

Syed Ahmad Helmi Syed Hassan, Mohd-Yusof, K., Mohd Salleh Abu and Shahrin Mohammed (2011). “An Instrument to Asses Students' Engineering Problem Solving Ability in Cooperative Problem-Based Learning (CPBL)”, Proceedings for the 2011 ASEE Annual Conference and Exposition on Engineering Education, Vancouver, Canada, June 26-30.

The Royal Academy of Engineering (2007). *Educating Engineers for the 21st Century*. London: The Royal Academy of Engineering

Woods, D. R. (1996). *Problem-based Learning: Helping Your Students Gain Most from PBL*, (3rd ed.). Ontario, Canada: D. R. Woods Publishing.

A Study in New Engineering Education With the Local Community as the Classroom
- Possibilites and Challenges for Approaching Project Based Learning -

Setsuko ISODA*, Sadayuki SHIMODA*, Tadashi UCHIYAMA*

** Department of Architecture and Civil Engineering, Kumamoto National College of Technology,*
2627 Hirayamashinmachi, Yatsushiro City, Kumamoto 866-8501, JAPAN

Abstract

The Department of Architecture and Civil Engineering has organized ways of learning actively for students based on educational experience and currently tries to implement an educational program for the new training curriculum of engineers in our department. This paper presents our efforts in the two Good Practice (GP) programs including lesson content and methods of assessment and evaluation of efforts in addition to problems that must be solved for approaching the Aalborg PBL model of Project Based Learning in the future. The Possibilities, task and challenges of new engineering education with the local community as the classroom are discussed.

Keywords: Engineering Education, Active Learning, Community, Department of Architecture, Curriculum, The Aalborg PBL Model

1. Introduction

It is the purpose of this paper to discuss the possibilities of a new engineering education program with the local community as a classroom which has been implemented in the Department of Architecture and Civil Engineering (AC), Kumamoto National College of Technology (KNCT) and to consider the challenges it needs to overcome for approaching the Aalborg PBL Model of Project Based Learning (PBL).

1.1. Activities receiving Financial Support from the Japanese Ministry of Education

The AC department of KNCT performed several engineering education activities with the local community as classroom e.g. The Shinkansen Station Project (2004), The Planning of Demachi Park Project (2002~2003) and The Bicycle Town Project for Elderly People (2003).

Since 2007, based on these experiences, by receiving funds from the Support Program for Contemporary Educational Needs of the Japanese Ministry of Education, many practical approaches to classwork have been addressed in earnest under the project of “Revitalization of the Local Hot Spring Town close to our College”. Through these approaches, students worked with real life complex problems such as architectural design and were required to solve them in class.

In addition since 2010, a grant from the Support Program for Promoting High-Quality University Education helped us to reorganize and systematize the existing traditional curriculum of the AC department in KNCT in order to approach the Aalborg PBL Model of a Project Based Learning (PBL) curriculum.

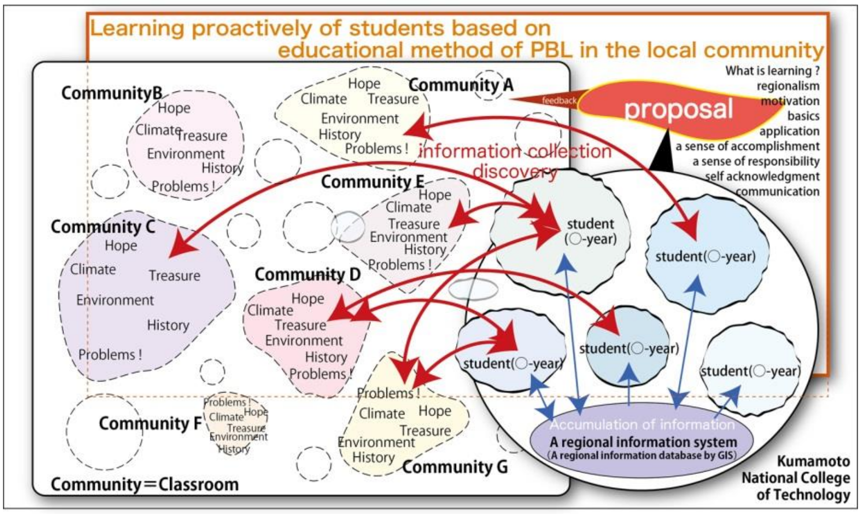

Figure 1. Conceptual Diagram of Students’ Active Learning through involvement with the local community

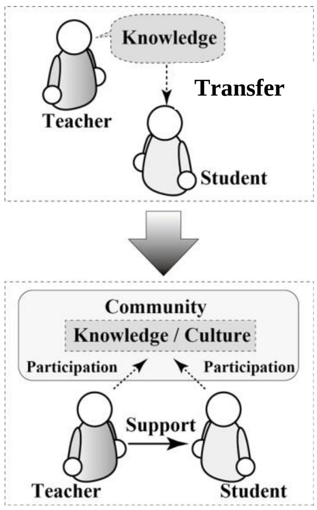

Figure 2. Relationship between teachers and students (based on Sasaki, 2012, pp111-112)

* Setsuko ISODA. Tel.: +81-965-53-1347
E-mail address: isodas@kumamoto-nct.ac.jp

1.2. The meaning of learning with the local community

As mentioned before, students are required to solve real life complex problems in the process of learning with the local community. Therefore, the local community is an ideal place to develop students' abilities in problem solving.

As Saeki (1995, p41) says that understanding must be through experience underscoring the importance of the experimental learning of students with the local community.

From our experience of learning with the local community, the relation between teachers and students becomes a more horizontal one (Figure 2); i.e. teachers and students work together to solve difficult real life problems. This is very important to develop students' active learning.

In this way, learning with the local community allows students move outside the college classroom. They learn about the local community in the classroom but advance to learning through real life complex problems with the local community. By steadily repeating and accumulating these processes of learning through the projects, we intend to approach a new style of Engineering Education.

2. Discription of the New Engineering Education with the Local Community as Classroom

2.1. Past Projects

The Department of AC has made efforts on projects based on actively involvement with the local community for 11 years, from 2001 through 2011. 53 projects were undertaken as part of this effort in 14 subjects, accounting for approximately 64% all of lectures and seminar classes. The 5th year has eight subjects (26 projects) that apply to this effort, which is the largest number for any year. Two of the subjects (14 projects) are in the 4th year and four subjects (13 projects) belong to the 1st-3rd years. In the Advanced Engineering Courses, out of 11 elective subjects in construction include such projects. Extra-curricular activities outside the classroom have also been performed, including co-exhibitions of architecture with local architects and a collaboration project with the Chamber of Commerce regarding revitalization of the downtown. Extracurricular activities are multidiscipline cross the year, and have a great potential to promote active learning by students.

2.2. Goals, Topics and Relevance to Classwork

As shown in Figure 3, approximate goals are set for each school year, which are coordinated in connection with social activities in accordance with each goal. Students acquire specific skills, corresponding to their school year while building up their overall knowledge in a spiral.

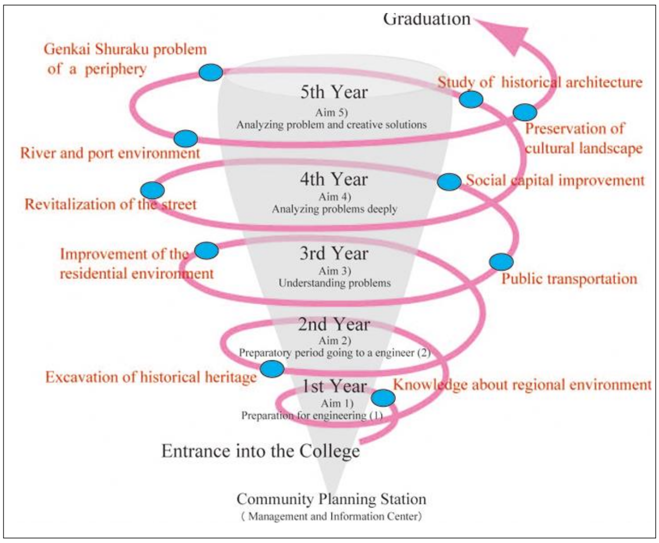

Figure 3. Relationship between the Curriculum of Department of the AC Department and New Engineering Education in Collaboration with the Community

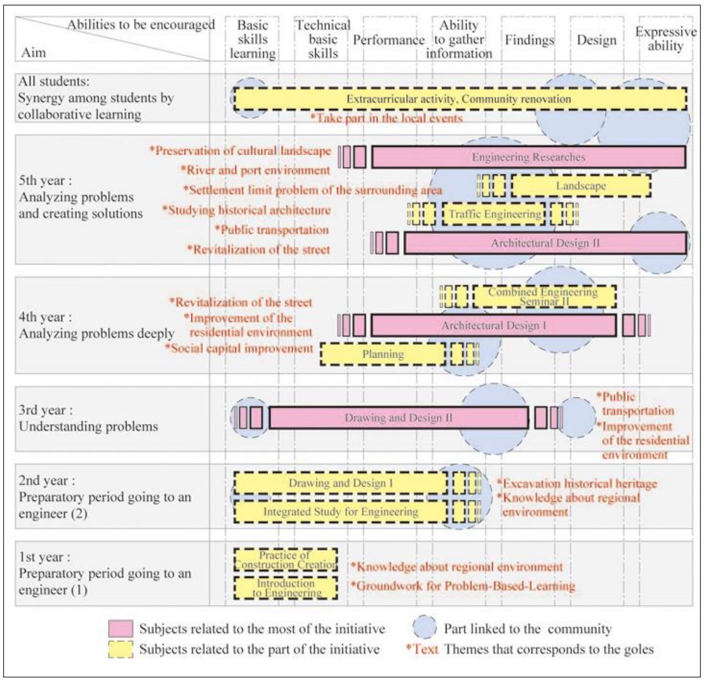

Figure 4. Relationship between the goals of the five levels and the abilities to be developed through subjects and themes

Figure 4 shows the relationship between the overall goals, the abilities to be developed and the community projects. For example, the 3rd year Drafting and Design class mainly develops basic learning skills, technology skills and ability to gather information. This class deeply involves the local community during information collection. The 4th year Architectural Design class focuses on applied skills such as proposals and design and involvements with the local community shifts to problem identification.

Figure 5. Introduction to Engineering (the 1st year)
Students extract keywords from a picture book and organize their relationship to architecture.

Figure 6. Introduction to Engineering (the 1st year)
Students measure body dimensions to learn their relationship between the furniture dimensions.

Figure 7. Field survey of the 3rd year
Local residents describe the situation in the region.

Figure 8. Presentation of the 3rd year held in the community in order to facilitate participation of local residents.

Figure 9. Field excursion of the 4th year
Students visited local elementary schools, and received an explanation from the principal.

Figure 10. Presentation of the 4th year
We invited experts and the principal of an elementary school. Students made a presentation of design proposals and received advices about it.

Figure 11. Group work of the 5th year
Toward the presentation, students discuss the layout of the drawings.

Figure 12. Review meetings of the 5th year
Professional lecturers invited three times during students lectures give advices on design proposal.

Figure 13. Participants summarized the concept of extracting keywords.

Figure 14. In the extracurricular activity workshop, students explain the design proposal being finalized.

Figure 15. In extracurricular activity workshop, students explain the design proposal on site to participants using a mock-up.

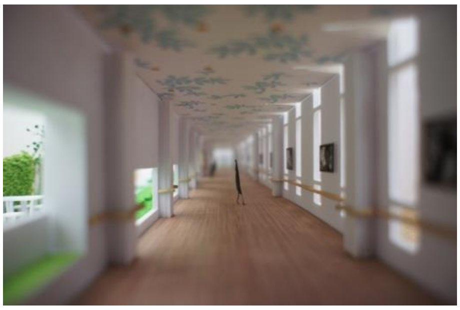

Figure 16. In extracurricular activity workshop, students describe the final draft of the model

Table 1. Projects "actively involved with the local Community"

Year	Course Title Themes	Aim	Method of practice Relationship to community	A assignment
All students	Extracurricular activity “Hospital Gallery” 5 times * 150 min	Synergy among students by collaborative learning · To learn to design in detail through the design of fact or the experience a variety of problems. · To improve skills that can be explained and can be easily understood presentation, about designing own proposals and ideas. · To improve skills of consensus building and communication with people who are different professional field. · To improve a technical basic skills and learning, through collaboration with other students.	· Divide into 4 groups of about 10 people, doctors and the hospital staff, local high school students (in charge of photo exhibition), and our college students. · Each group extracts keywords describing a good gallery, and our college students make a design based on the keywords. Each group refines the design while discussing whether it is suitable as a hospital gallery based on the previous design. · After the design is decided to some extent, they create a mock-up, and considered the design in detail.	This project involves actual refurbishment of the hospital, plans to take advantage of the passage as a gallery of 61m in length. This long corridor is designed as a healing space for not only patients and their families, but also local residents.
5th year	Architectural Design II Design Competition of National College ”EARTHTECTURE” 33 times * 100 min	To tackle creatively to solve problem · To improve skills to find the documentation that may help to design while studying the reference. · To improve the ability to propose, to design, such as the solution of a problem. · To improve skills that can be explained and can be easily understood presentation, about designing own proposals and ideas.	· Groups of 3-4 people · Each group discusses issues, and proposes a design for problem solving. · In a surrounding or nearby region, each group set a specific location, and proposes an attractive design.	The theme of spatial design department of Design Competition of National College. To plan a space be integrated into the landscape as architecture rooted in local culture. To propose unique and attractive architecture rooted in the local culture, in the neighbourhood area.
4th year	Architectural Design I “Elementary school that is open to the community, after 30 years” 16 times * 100 min	To think thoroughly about the issue and how to resolve it. · To consider key goals and problems for the design; through field survey and group discussion. · To develop skills to find the documentation that may help to design while studying the reference. · To develop the ability to propose, to design, such as the solution of a problem.	· Groups of 4-5 people · Each group decides on the field surveys to understand the problem. Each group interviews residents, and examine traffic flow. Field survey is carried out several times. · All processes, field survey, studying of the plan, final presentation, is carried out by each group.	It is important to study the relationship with elementary school and the local area, considering the declining birth rate. Students make a proposal about the elementary school after 30 years while studying what specifically it makes to be " open to the local community".
3rd year	Drawing and Design II “Planning of the front and house on Shin-Hinagu Spa Station” 15 times * 100 min	To think the solution, or the goal through the group work. · To consider key goals and problems for the design; through field survey and group discussion. · To develop skills to find the important documentation while studying the reference.	· Groups of 3-4 people Students learn the issue from local residents through field surveys, to understand the current problems. · If necessary, students go to the field survey to extract new problems. · The concept is determined by the group, the design is drawn by an individual. · Each group makes a final presentation board with individual designs and explains it to local residents.	Because the present station is about 500m away from Hinagu-spa town, it is difficult to access to the spa town from the station. Local residents have also been hoped a new station around this site closer to Hinagu-spa town. Our proposal is to design a new Shin-Hinagu-S pa Station considering the surrounding environment or region.
2nd year	Integrated Study for Engineering 2 times * 100 min	Preparatory period to be an engineer (2) · To understand the characteristics of the region. · To get ideas through the experience of group work, PBL and the connection with the local community.	· Groups of 5-6 people · Each group performs a field survey in the Hinagu-spa town studying the characteristics of the region.	
1st year	Introduction to Engineering Workshop style 5 times * 100 min	Preparatory period to be an engineer (1) · To raise students' interest in field of expertise. · To motivate learning. · To lead to a active learning and PBL.	· Groups of 4-5 people Workshop on the theme of "architecture and a picture book", "architecture and body", "architecture and life", "Architecture and Information". · Students learn the relationship between architecture and daily life. · Through group work, students understand different views of others and learn the diversity of sub-disciplines.	

2.3. Concrete Examples of Recent Projects

Here we introduce some class and extra-curricular activities among those undertaken from 2011 to 2012 in the Department of AC. Figures 5-16 show photographs of specific activities different school years. Additionally, table 1 gives the aims of the topic for each subject and method of practice, relationship with the community, and the assignments related to the activities shown in figures 5-16. The general characteristics of the projects are as follows:

1. All assignments are carried out in groups.
2. From the 2nd year on the class linked to the local community in some way.
3. Wherever possible, the assignment theme is a current regional issue.
4. We encourage voluntary participation in the collaboration or presentation of students to residents and relevant authorities.
5. Seminar classes are taught by more than one teacher.
6. We developed a local information-sharing system using Google Earth. This system is collaborative and searchable and includes local town information, students work and information on the characteristics of the field of architecture and civil engineering.
7. We recommend initiatives that go beyond the school year.

3. Student Questionnaires

3.1. Assessment of the results

Assessment of individuals in group project work is a problem, but the Department of Architecture at Aalborg University has implemented advanced approaches combining individual assessment by oral examination and assessment of artifacts in the group. In our works, we gave similar oral examination questions as written assessments to students and their responses were reflected in our assessment. We also carried out peer reviews of the students.

3.2. Assessment of attitudes to the projects

The Department of AC requires much general knowledge for students, because projects are closely related to a society. In addition, the engineering work environment requires extensive collaboration with other specialized fields, and ability to exchange opinions and work together is necessary. As such abilities are related to personal attitudes towards society and others, EQ (Emotional Intelligence) as advanced by Daniel Goleman was fund to be useful. Goleman states that sense of values and ability to respect consideration, self-control, cooperation, and harmony are important. They are considered to form the background of the desire to learn and willingness to contribute to social activities. Therefore, we considered EQ to be a fair assessment of attitudes towards work.

For the education of engineers in our department, EQ is related to the following. They can be learned through group activities and involvement with the community and enhance their learning motivation, so students aim to produce good work in cooperation. Trough EQ tests on a regular basis, we can continue to observe whether the students have mastered basic abilities and attitudes of engineering education.

We created an EQ test of 40 questions in total: four questions corresponding to 10 items. Each question was graded on a Likert scale of 1 to 5 corresponding to "completely disagree" "somewhat disagree" "cannot say" "somewhat agree" "completely agree". The questionnaire was conducted three times between 2010 and 2012. Figures 17-22 show the results. We identified trends and changes in students EQ values based on these results.

Figures 17-19 show the averages of the four questions corresponding to the 10 items; items by school year. Scores over 3.0 indicates positive trends and scores under 3.0 indicate negative trends.

Results of the analysis are as follows. The 4th year and 5th year results spread outward compared to other years, and 2nd and 3rd year results tend to fall near the center of the circle. Thus the EQ value tends to rise as the school year increases. The change in the EQ value from 3rd to current 5th year in the same class is shown in Figure 20. Figures 21 and 22 show the change in the value of EQ in the current 3rd and 4^{h} years. As shown in Figures 20 and 21, the outermost spread occurs at 4th and 5th years. We believe this shows that students have been able to master basic abilities and attitudes toward learning through this engineering education with the local community as classroom. The EQ in Figure 22 is almost unchanged, but tends to be smaller in the 3rd year showing that the EQ value is generally maintained.

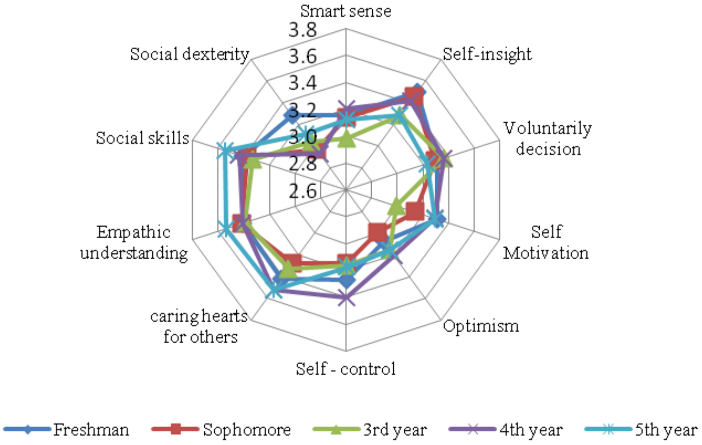

Figure 17. EQ results of November 2010

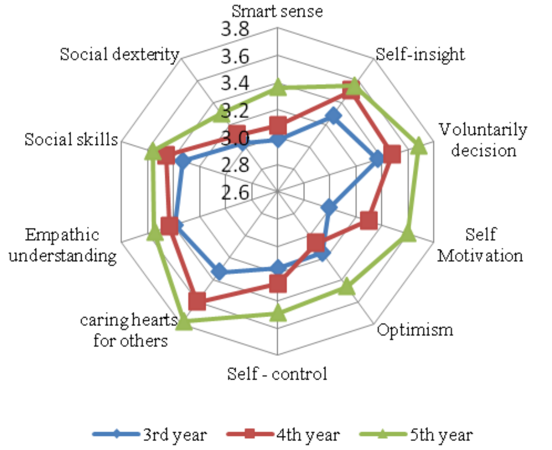

Figure 20. The results of the past three EQ current fifth year

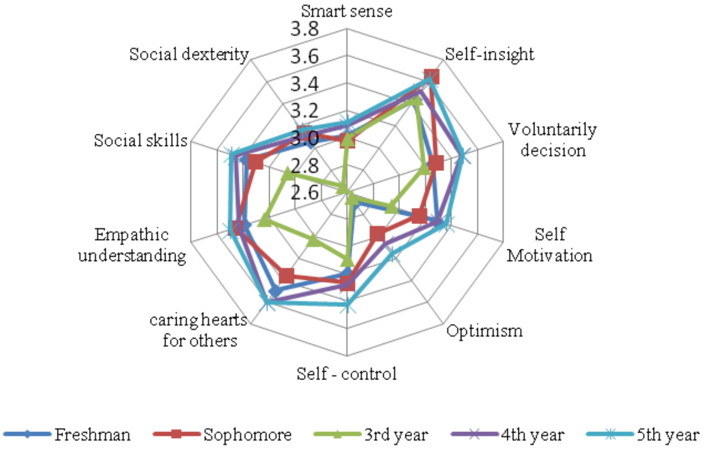

Figure 18. EQ results in May 2011

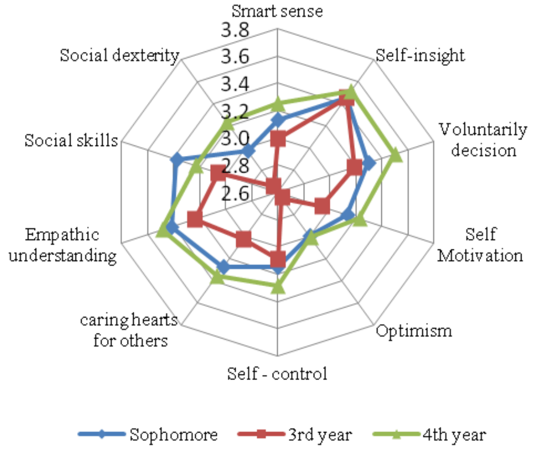

Figure 21. The results of the past three EQ current fourth year

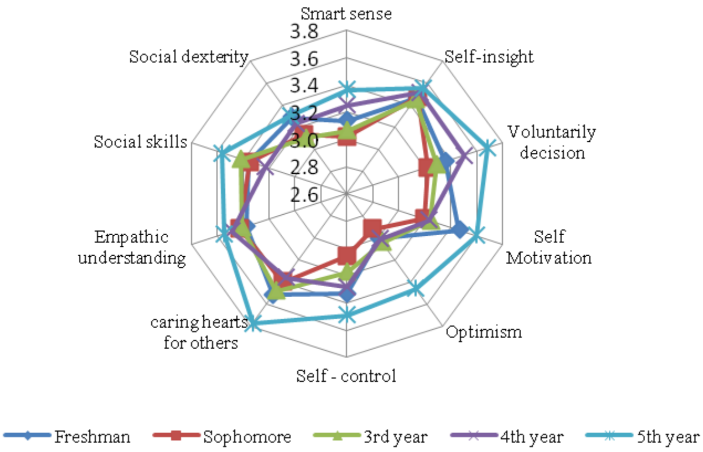

Figure 19. EQ results of May 2012

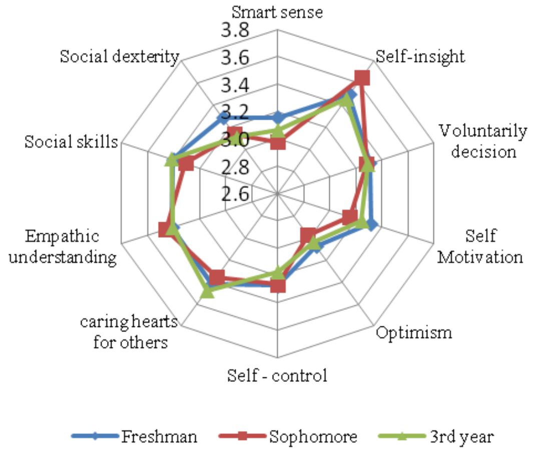

Figure 22. The results of the past three EQ current third year

4. Future Challenges

4.1. Common points between our approach and The Aalborg PBL Model

Our approaches are important meaning in raising students' motivation to learn through social connection with the local community and improving the effect on the engineering education. In learning with the local community, students find their own aims to learn and their image as future engineers. On the contrary, Nakao (2009, p6) points out that students tend to lose their visions in the traditional learning style where teachers communicate knowledge one-sidedly to students.

In the Revitalization of the Local Hot Spring Town, our approach did not have a clear intention of PBL. But after having learned about PBL through conferences with members of Toyama National College of Technology, Kumamoto University and through inspection at Aalborg University, we found that our approach has much in common with the Aalborg PBL Model. Our approach has four basic points in common with the Aalborg PBL Model as follows:

1. Relation to social connection with local community involving community residents, local government and local companies
2. Involvement of real life problems
3. The teacher's role
4. Group work

4.2. Significant points of difference between our approach and The Aalborg PBL Model

On the other hand there are indeed significant points of difference: specifically the purpose of learning and the curriculum itself.

4.2.1. The purpose of learning

Table 2 compares the KNCT purpose of learning with those of Aalborg University. The main purpose of learning of KNCT is to ensure professional and technical knowledge. On the other hand, the main purpose of Aalborg University is to secure continued professional development throughout the student's career via lifelong learning, i.e. "learning to learn".

Table 2. The Purpose of Learning

Aalborg University	Kumamoto National College of Technology
To secure continued professional development throughout the student's career via lifelong learning, i.e. "learning to learn"	To ensure professional and technical knowledge
PBL Introduction, The Department of Development and Planning, Aalborg University, Sep. 1st 2012	Handbook for student of KNCT

4.2.2. The curriculum

Diagrams of The Aalborg PBL Model and the KNCT AC curriculum are shown in Figures 23 and 24. The KNCT AC curriculum is a traditional one that is common to almost all Japanese Universities and National Colleges of Technology. There are many special subjects and they have almost no relevance to each other. Teaching is generally left to the professors. Our approach to teaching with PBL methods is only used in a few courses, under the traditional curriculum (Figure 24). Most so-called PBL approaches in Japan are in almost the same situation.

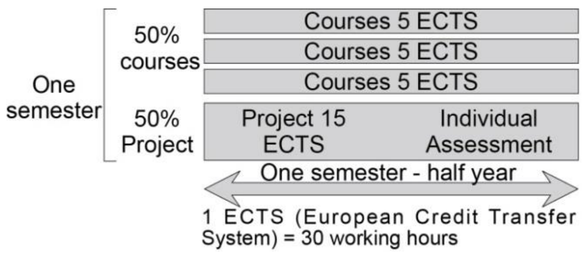

Figure 23. Aalborg New Model

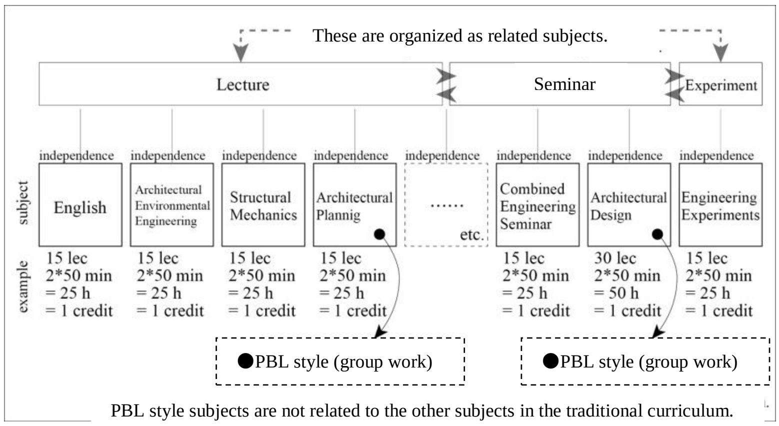

Figure 24. Diagram of the Department of AC curriculum

4.3. Critical challenges to solve for approaching The Aalborg PBL Model

The critical challenges to solve for approaching to PBL are as follows:

1. Reorganization of the existing traditional curriculum to a Student-Centered PBL curriculum in KNCT there are only a few subjects that implement learning methods of PBL under the traditional curriculum. It is necessary to reorganize the traditional existing curriculum to one of PBL as the Aalborg Model so that our approaches can be more easily to practice.

However, the national architect qualification license examination is a big obstruction to reorganizing the curriculum, because candidacy for this examination requires completion of each special subject of architecture.

2. Construction of a new assessment system along with reorganization of the curriculum, it is necessary to construct a new assessment system.
3. Physical space for student project groups there is only one room exclusively for group work in our College. Adequate physical space for student project groups must be provided.

The approaches being taken toward Student- Centered PBL at present are as follows:

1. Increasing the number of class subjects of PBL-style learning under the traditional curriculum
2. Analyzing the depth of student learning through their experience of learning with the local community and reconfirmation of significance of the relevance with the local community.
3. Examining and improving problem and theme setting and assessment and how to give encouragement to students in the project.
4. Producing evidence of improvement of the quality of humanity and engineering competence of students by PBL style learning using EQ.
5. Preserving and displaying excellent student project work.
6. Maintaining relationships with the local community.

5. Conclusion

This paper introduced ten years of work in the Department of Architecture and Civil Engineering at KNCT and discussed problems that must be solved for approaching the Aalborg PBL Model of Project Based Learning. Although these approaches have been addressed mainly in the AC Department, it is possible to apply such learning methods to the other departments. At first, we need to reorganize the existing traditional curriculum of the AC Department. Thus, although it is may be preferable to approach PBL in only one Department, but it is very important that all departments in our college work to develop simultaneously for excellent educational effects of PBL on students.

Difficult problems continue that need to be solved, and further earnest efforts are required to decide a concrete policy towards PBL in KNCT.

Thanks

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References

Kolomos, Anette. Flemming K. Fink and Lone Krogh (eds.), (2004). The Aalborg PBL Model - Progress, Diversity And Challenges, Aalborg University Press.

Golman, Daniel, (1995). Kokoro no chino-shisu[Emotional Intelligence Why it can matter more than IQ (in Japanese)], Hardcover edition, Kodansha

De Graaff, Erik and Anette Kolmos (Eds.), (2007). Management of Chage: Implemantation of Problem-Based and Project-Based Learning in Engineering, p1-7, Sense Publishers.

Aalborg University, Principles of Problem and Project based Learning The Aalborg Model, (2010). Aalborg University.

KNCT, Handbook for student of KNCT (in Japanese), 2012.

Kolmos, Anette, The Aalborg PBL Model, March21st, 2011, Aalborg University.

Motoki Nakao, Engineer Education Program based PBL (in Japanese), Letter of Kyushu Institute of Technology Vol.34, 2009, p6.

PBL Introduction, Department of Development and Planning Aalborg University, September1st , 2012.

Saeki,Yutaka, (2000). Manabino Kozo [Structure of Learning (in Japanese)], p41:Toyokan Publishing.

Saeki,Yutaka, (1995). Wakaru to iukotono imi[he Meaning of Understanding (in Japanese)],pp111-112,Iwanamishoten.

Miyagawa, Hideaki.Setsuko Isoda, Sadayuki Shimoda, and Tadashi Uchiyama, (2013) A Study in New Engineer Education that Actively Involved the Local Community(in Japanese),pp105-111,J. of JSEE,61-1

How effective is the assessment of generic skills gained by Technical Vocational Education and Training (TVET) of engineering students engaged in Problem-Based Learning (PBL)? – A Literature Review

Daud M.F. [a]

[a]*Muhamad Farid Bin Daud, Aston University, Birmingham and B4 7ET, United Kingdom*

Abstract

The review of the literature for this study focusses on PBL approach within the Technical Vocational Education and Training (TVET) of engineering, and the development of assessment on engineering students' generic skills. Key findings of the research point to four aspects: inter engineering disciplines; different cultures; different education policies; and world globalization with rapid technology changes; will be considered during designing the assessment. The identification and the development of measurable and reliable method for assessing the engineering students' generic skills through PBL approach are crucial to the overall success of the respective Technical Vocational Education and Training (TVET) institution.

Keywords: Generic skills, problem-based learning, assessment, technical vocational education and training (TVET), engineering;

1. Introduction

Graduates from higher education who grasps generic skills competencies during studies have added value in their career development. With the dramatic changes in technology, graduates should be able to digest, apply and distribute information with precision and ease. Young and Chapman (2010) commented in their research, employers who operate in global markets now seek employees who possess not only high-level technical or 'job-specific' competencies, but also, high levels of communication skills, problem solving and conflict resolution (p. 1).

The generic skills in this research refer to the problem solving, critical thinking, communication and life-long learning skills of graduates. Therefore, this paper aims to critically assess the effectiveness in terms of reliability, measurability and validity of the assessment methods of generic skills through PBL approach amongst Technical Vocational Education and Training (TVET) engineering students. To achieve the above aim, the paper begins by looking at the terminology of generic skills in different countries and the importance of generic skills at the workplace. The paper thus discusses the approaches used in the generic skills development especially in Technical Vocational Education and Training (TVET) perspective. The next part of the paper focuses on the generic skills assessment methods through PBL approach and the problems faced in verifying the assessment in PBL.

The paper concludes that the aspects in inter Technical Vocational Education and Training (TVET) disciplines, different cultures, different education system policies, and globalization alongside rapid technology changes will be given due consideration when designing the generic skills assessment. This research will contribute a positive impact on PBL assessment especially in Technical Vocational Education and Training (TVET) engineering students' generic skills achievement in a measurable context. Indirectly, it may also be deemed as a performance indicator of the Technical Vocational Education and Training (TVET) institution and Ministry of Higher Education respectively. This would be the focus of this research as emphasized in the research question and objectives.

Muhamad Farid Daud. Tel.: +44-121-204-3502
E-mail address: daudmfb@aston.ac.uk

2. Background – Context: Generic Skills in Technical Vocational and Education Training (TVET)

Generic skills are the skills that students need to become more successful learners and successful practitioners in their field of study, work and other aspects of their life are an important outcome of university education (Allan & Clarke, 2007; Bennett, Dunne, & Carré, 1999; Biggs, 2003). The terminology used to refer to generic skills differs from one country to another. (NCVER, 2003). The terms includes: 'key competencies', 'soft skills', or 'employability skills' (Australia); 'key skills' or 'core skills' (United Kingdom); 'essential skills' (New Zealand); and 'necessary skills', 'employability skills' or 'workplace know-how (United States). Essentially, the terms refer to the same skills as shown in Table 1.

Though an academic qualification is the more important criterion that an employer looks for, what differentiate graduates from other graduates are their interpersonal skills, communication skills, critical thinking and problem solving skills. Hamzah and Abdullah (2009) suggested that any organization's portfolio should include the generic requirement for each job so that the prospective employees can make necessary steps to equip themselves for the job and know their competency level (p. 688). Lack of these skills will effect on job opportunities as reported in The Chronicle of Higher Education on 5th December 2011, employers say college graduates lack of job skills and this is supported by Mail Online, London, England reported on 26th January 2012, that one in three top companies can't fill graduate vacancies: Too many leave university without the right skills, say bosses. While "Too many young people lack the social skills needed to get their first job" the statement appeared in the BBC News Education and Family on the 23rd May 2012. Jideani and Jideani (2012) stated "academic success is not in terms of what students can remember, but in terms of what students are able to do with their knowledge" (p. 34) which is also referring to the life-long learning capabilities.

Globalization and rapid changes in technology imply the need for workforces that not only have specialist knowledge and skills, but have developed the generic skills needed to adapt quickly to new emerging technologies (UNESCO, 2012). With respect to that circumstance, the education in the 21st century has had a considerable impact on learning and teaching approach adopted in further and higher education especially in the Technical Vocational and Education Training (TVET) engineering discipline. Typically, most of the technical and vocational subjects are still delivered using traditional of four step method training of Allen (1919) approach which starts with describe, demonstrate, try-out by trainee and evaluate with feedback. However, students trained via Allen (1919) approach are lack with the required generic skills by the employer such as problem solving, critical thinking, communication and life-long learning. Though generic skills are important for the graduates during the job hunting, it is also a need for them to acquire technical skills through hands-on experience that will enable them to solve problems which emulate industrial problems. Instead of spoon-feeding students with fundamental theories and ideas, Problem-Based Learning (PBL) is one of the active learning approaches that have been introduced as an alternative and integrated way in Technical Vocational Education and Training (TVET) learning and teaching (Masek & Yamin, 2010; Nur Sofurah Mohd Faiz, Mamat, Mohamed, Sulong, & Burhannuddin, 2008).

Technical Vocational Education and Training (TVET) have been known as an education and training system to produce highly skilled workforce and knowledgeable manpower particularly in modern careers. Political and economic leaders around the world acknowledge that the workforce skill level is what determines the economic performance (Benjamin et al., 2012). Consequently we witness the development of many vocational and technical training institutions and universities in the effort to fulfill these needs in developing or developed countries (Tabbron & Yang, 1997). Adopting PBL in engineering teaching approached have significantly improved the students' personalities and attitudes (Prince, 2004). Instead of curriculum development, learning outcomes and policies, assessment is the main criteria to measure the quality of the engineering students and Technical Vocational Education and Training (TVET) institutions. Currently, the assessment on the academics is very objective and well structured, which leaves the generic skills assessment to be subjective and immeasurable. A valid, measurable and up-to-date assessment method will be designed in order to measure the effectiveness of the Technical Vocational Education and Training (TVET) engineering students' generic skills: problem solving; critical thinking; communication; and life-long learning; and to assure the quality of Technical Vocational Education and Training (TVET) institution respectively.

3. Discussion: Components of PBL – Brief Overview of Different Learning Approach

3.1. Active Learning

Active learning is contrasted to the traditional way of learning where students passively receive information from the instructor. It is generally defined as any instructional method that engages students in the learning process (Prince, 2004). Drake (2012) agreed with Prince but added that the students need to be responsible for their own learning. While Felder and Brent (2009) defined active learning as "anything course-related that all students in a class session are called upon to do other than simply watching, listening and taking notes" (p. 2). The most commonly cited definition of active learning comes from Bonwell and Eisen (1991) "Involving students in doing things and thinking about what they are doing" (p. 2). And we may have heard - "Tell me and I forget. Show me and I may remember. Involve me and I will understand" (Confucius, c.500BC). Though it is just a simple statement, it makes complete sense from the learning and teaching perspectives.

Different methods of active learning that most frequently discussed in the engineering literature are collaborative learning, cooperative learning, Conceive-Design-Implement-Operate (CDIO), Experiential Learning Theory (ELT) and Problem-Based Learning (PBL). Collaborative learning may refer to any instructional method in which the students at various performance level work together in small groups towards a common goal (Gokhale, 1995). As such collaborative learning can be viewed as encompassing all group-based instructional methods, including cooperative learning (Prince, 2004). Prince also added, some authors distinguish collaborative and cooperative learning as the collaborative learning is the emphasis on students' interaction rather than on learning as a solitary activity.

Cooperative learning is defined as a structured form of group work where students pursue common goals while being assessed individually (Panitz, 1996; Prince, 2004). Unlike less structured forms of collaborative learning, cooperative learning requires students to be individually responsible for their own learning. Therefore the teacher or facilitator need to carefully design the learning activities and regularly monitored as Smith, Sheppard, Johnson, and Johnson (2005) quoted "engaging students in learning is principally the responsibility of the teacher" (p. 2).

Another method of active learning is the CDIO. In the late 1990s, CDIO concept was originally conceived at the Massachusetts Institute of Technology. CDIO provides the students with engineering fundamentals set in context of conceiving – designing – implementing – operating industrial systems, industrial equipment and products (Crawley, Malmqvist, Ostlund, & Brodeur, 2007). Crawley et al. (2007) listed three overall goals for CDIO, which are the students, should be able to:

- Master a deeper working knowledge of technical fundamentals.
- Lead in the creation and operation of new products, processes, and systems.
- Understand the importance and strategic impact of research and technological development in the society (p. 2).

Experiential Learning Theory (ELT) has been introduced and widely used in human learning and development. The theory is called "experiential" is its intellectual origins in the experiential works of Dewey, Lewin, and Piaget. Taken together, Dewey's philosophical pragmatism, Lewin's social psychology, and Piaget's cognitive-developmental genetic epistemology form a unique perspective on learning and development (David A Kolb, Boyatzis, & Mainemelis, 2001; David A. Kolb, 1984).

3.1.1. Problem-Based Learning (PBL)

PBL approach is common in medical institutions. The approach was also largely conceived and developed in the academy, initially for training lawyers and clinical practitioners and subsequently adopted for other professional courses (Savin-Baden, 2000). Nevertheless, it is just as appropriate for technical vocational subjects, including family and consumer sciences, and traditional academic subjects (Ward & Lee, 2002). The rationale behind the statement is, in Technical Vocational Education and Training (TVET) the students need to master the hands-on skills and not so much on critical thinking skills as training lawyers and clinical practitioners. Therefore, there will be a difference of PBL implementation and assessment approach in Technical Vocational Education and Training **(**TVET) as compared to medical where PBL originated.

PBL is an innovative approach to learning that teaches a multitude of strategies critical for success in the twenty-first century (Bell, 2010). She also added through the problems, students gain knowledge from group discussions and asking questions that have piqued their natural curiosity to learn (p. 39). Savin-Baden (2000) defined PBL as an approach to learn through which many students have been enabled to understand their own situations and frameworks so that they are able to perceive, how they learn, and how they see themselves as future professionals (p. 2). In PBL, teachers act as facilitators, moderators or advisors (Ward & Lee, 2002) to oversee each step of the process, give feedback and approve each choice before student embarks on a direction (Savin-Baden, 2000). This will help the students to develop self-reliance and life-long learning in them.

The main goals of PBL are to help the students develop their generics skills such as flexible knowledge, effective problem-solving skills, self-directed learning, effective collaboration skills and intrinsic motivation (Hmelo-Silver, 2004; Tchudi & Lafer, 1996). In PBL environment, the contents are transformed into ill-structured problems to provide more realistic approach to learning and to create an educational methodology which emphasizes real world challenges, higher order thinking skills, multi-disciplinary learning, independent learning, teamwork and communication skills which motivate students to prolong lifelong learning (Paul, 2010).

Boud and Feletti (1998) considered PBL as one of the most influential of the last decades and defined it as a carefully planned curriculum, which is entirely based on solving practical problems and practical cases. According to Meier, Hovde, and Meier (1996), students taught within the lecture-based disciplinary system typically have not been able to solve problems that require them to make connections and use relationship between concept and content. While in interdisciplinary teaching, it starts with a topic, theme, problem, or project that requires active student engagement and knowledge of multi-disciplines in order to reach the learning outcome. In PBL (Savin-Baden, 2000) concerned that, the focus in organizing the curricular content is around problem scenarios rather than subjects or disciplines (p. 3). Because PBL is often interdisciplinary in nature, teacher need to recognize the connections between discipline and collaborate with other teachers in developing learning experiences that provide relevant application of contents and skills (Meier et al., 1996; Ward & Lee, 2002).

However, Prince (2004) argued, based on the literature, faculty adopting PBL are unlikely to see improvement in student test scores, but are likely to positively influence student on attitudes and habits in learning independently. This is the strength in PBL. The learning uses relevant applications that motivate students to search for a need of facts and not being dependent on the teacher. Masek and Yamin (2010) described PBL as one of the methods which resulted to Student Centred Learning (SCL) (p. 10). This method encourages students to solve relevant problems within groups and classes using the prior knowledge and available resources.

Prince (2004) suggested that the engineering faculty should be strongly encouraged to look at the literature on active learning because some of the evidence for active learning is compelling and should stimulate faculty to think about teaching and learning in non-traditional ways (p. 3). Ozbicakci, Bilik, and Intepeler (2012) concerned in order to create a student-centred approach through PBL also requires faculty to give up traditional ways of instruction and places the responsibility for learning squarely on student (p. 79).

3.2. Assessment in PBL

The essential feature of a teaching system designed to emulate professional practice is that the crucial assessments should be performance-based, holistic, allowing plenty of scope for students to make their own decisions and solutions (Biggs, 2003). Generic skills assessment in engineering is a major challenge in PBL (Zulkifli Mohd Nopiah, 2009). Prince (2004) added skills in problem solving and life-long learning are difficult to measure which resulted in data are less frequently available for these outcomes than for standard measure of academic achievement (p. 2).

Agreeing on what is to test and what is to focus is a matter of much debate. Assessment in PBL requires as much care and consideration as it is under other approach to learning and teaching. The consequence of this is that, if lecturers retain the assessment methods they use in their traditional curriculum approaches, the outcome can be a misalignment between their objectives and student learning outcomes (Mcdonald, 2005; Ozbicakci et al., 2012). Macdonald and Savin-Baden (2004) have a set of principles to guide in assessing students in enquiry and Problem-Based Learning. In most of the guidelines highlighted, the assessment should simulate what the professional does in their practice and ideally be based on a practice context in which students will find themselves in the future (p. 6). Mcdonald (2005) agreed and added assessment should also be moved beyond factual recollection to the application of knowledge and skills towards increasingly complex situations, involving a range of intellectual and practical activities in a variety of contexts. One of the approaches to ensure and assess the alignment of assessment methods with the learning outcomes is to use Bloom's taxonomy of cognitive domains (Jideani & Jideani, 2012). It is well-defined and broadly accepted tool for categorizing types of thinking into different levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Crowe, Dirks, & Wenderoth, 2008).

In order to analyse perceptions of the depth of understanding that students acquire, the lecturer must not discriminate students and should assess fairly with strong justifications, in other words being objective. In some cases reported by Bollela, Gabarra, da Costa, and Lima (2009) research outcomes mentioned the reluctance of the lecturer to award high marks to the student because of student's immaturity and sincerity. Since the human perceptions and assessment is very subjective, it is also happens during the peer- and self-assessments among the students. Reflection or peer assessment and self-assessment requires students to reflect and evaluate their own participation, learning progress, and products of autonomous learning (Hart, 1994). They evaluate not only their learning, but also the success of their social interactions (Bell, 2010). Papinczak, Young, and Groves (2007) mentioned in their research that performance of their peers is better compared to their own performance (p. 122). The studies have confirmed that self-assessment of process is not an accurate measure compared to their peers.

There are several methods used previously to measure student skills, performance and progress. One potential assessment has been developed by Novak (1990) was Concept Mapping (CM) at Cornell University. CM is the metacognitive tool that was developed for the study to show changes in learning. Another appropriate assessment found by Gallagher, Sher, Stepien, and Workman (1995) using a lab notebook as the problem log to record ideas, plans, strategies and progress. It assessed the record of a students' thinking process and documented student participation. The common practice in PBL assessment is students prepare a portfolio for assessment that includes notes, commentaries and articles they have read, and discussions of the evolution of their ideas to formulate and report their findings and conclusion (Tai & Yeuen, 2007; Tchudi & Lafer, 1996; Ward & Lee, 2002).

Another potential assessment is the authentic assessment and rubrics that were used in high school family and consumer nutrition class (Ward, 1998; Ward & Lee, 2002). Authentic assessment is utilized as students were evaluated using appropriate rubrics. Authentic assessment are categorised into performance assessment, portfolio assessment and self-assessment (Hart, 1994; Tai & Yeuen, 2007). Boden and Gray (2007) also noted in their research, The Department of Aerospace at the United States Naval Academy (USNA) via CDIO syllabus have used rating scales (rubrics) for evaluating student performance in the form of journals of student reflections, portfolio of student work over time, capstone project, and during oral presentations, in-class discussions and technical reports (p. 119).

Bollela et al. (2009) concerned the major challenges when implementing PBL is the use of appropriate strategies to assess formative generic skills assessment of the students (p. 2). The existing substantial variation in the assessment of the PBL process is largely confined to formative purposes only. However, Knight (2001) notes in his research, assessment for summative purposes is viewed as being of such high stakes that those being assessed see it as being in their own interests to emphasise what they know or can do - however limited or poorly - and to cover up as much as possible what they do not know or cannot do. Upadhyay, Bhandary, and Ghimire (2011) recommended, in setting up the summative assessment of the PBL, the curriculum needs to be designed in an innovative way, adopting various strategies to foster such skills and behaviours and incorporating the measurement into the assessment (p. 1151).

Assessing "what works" requires looking at a broad range of learning outcomes, interpreting data carefully, quantifying the magnitude of any reported improvement and having some idea of what constitutes a "significant" improvement (Prince, 2004). No matter how data is presented, there is always the issue of interpretation, although it is helpful to look at both statistical measures. It is hard to develop questions that will measure creativity, critical thinking and generic skills. Tchudi and Lafer (1996); Ward and Lee (2002) describe assessment in PBL as a game that engages the student in guessing what teacher wants rather than demonstrating the best they can do. They even suggested if PBL changes the game and learning is to be seen as relevant to life, new methods are needed for the teacher to be able to assess student progress.

According to Joy and Kolb (2009), there is an impact of culture in learning style scales and in deciding a persons' preference for abstract conceptualization versus concrete experience. Reliability and validity of the generic skills assessment need to be designed personally based on the disciplines and cultures. If it is not to be considered, the consequences might turn out as reported in The Australian in Higher Education segment on the 16th March 2012, an interim evaluation of the Assessment of Higher Education and Learning Outcomes, or AHELO, has done the feasibility study on the US generic Collegiate Learning Assessment (CLA) test and found that it was hard to judge whether a generic skills assessment that was not linked to discipline content and different cultures, can be valid and reliable.

4. Conclusion

Based on the literature that has been reviewed, it will challenge the PBL assessment design to be more measurable and reliable especially in generic skills from Technical Vocational Education and Training (TVET) in engineering perspective. The aspects of inter disciplines, different cultures and education system policies need to be considered when designing the generic skills assessment. Globalization and rapid changes in technology must also be taken into account. As TVET students are expected to master the hands-on skills and not so much on the critical thinking, there will be a difference in PBL implementation and method of assessment.

This research will be using an inductive approach, where it will begin with PBL assessment observation and measures. Then detect the generic skills patterns and current assessment methods to measure the skills, formulate the tentative hypothesis and finally end up developing some general conclusions or theories. Details of the research methodological will be written in the future paper.

By determining the effectiveness of the students generic skills, the institute/university and Ministry of Education would be able to bring about curriculum change to help the students develop better skills. The author supports this with the claim that the development of quality, valid and reliable assessment method, and the engagement in actual assessment help to improve students and institute/university performance.

5. Tables

Table 1. Comparison of Generic Competencies

Australia	United Kingdom (NCVQ)	United States (SCANS)	New Zealand
Key competencies	Core skills	Workplace know-how	Essential skills
Collecting, analysing and organising information	Communication	Information Foundation skills: basic skills	Information skills
Communicating ideas and information	Communicating Personal skills: Improving own learning and performance	Resources Foundation skills: basic skills	Communication skills
Planning and organising activities	Personal skills: Improving own learning and performance	Resources Foundation skills: personal qualities	Self-management skills Work and study skills
Working with others and in teams	Personal skills: working with others	Interpersonal skills	Social skills Work and study skills
Using mathematical ideas & techniques	Numeric: application of numbers	Foundation skills: basic skills	Numeric skills
Solving problems	Problem-solving	Foundation skills: thinking	Problem-solving and decision-making skills
Using technology	Information technology	Technology Systems	Information skills Communication skills

Source: (Moy, 1999)

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References

Allan, J., & Clarke, K. (2007). Nuturing supportive learning environments in higher education through the teaching of study skills: embed or not to embed?. *International Journal of Teaching and Learning in Higher Education*, 64-76.

Allen, C.R. (1919). *The instructor: the man and the job : a hand book for instructors of industrial and vocational subjects*: J. B. Lippincott Company.

Bell, Stephanie. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House, 83*(2), 39-43. doi: 10.1080/00098650903505415

Benjamin, Roger., Klein, Stephen., Steedle, Jeffrey., Zahner, Doris. , Eliot, Scott., & Patterson, Julie. (2012). The Case for Generic Skills and Performance Assessment in the United States and International Settings. *Council to Aid for Education*, 30.

Bennett, Neville, Dunne, Elisabeth, & Carré, Clive. (1999). Patterns of core and generic skill provision in higher education. *Higher Education, 37*(1), 71-93. doi: 10.1023/A:1003451727126

Biggs, John. (2003). *Teaching for Quality Learning at University* (2nd ed.): Buckingham: Society for Research into Higher Education & Open University Press.

Boden, D.G., & Gray, P.J. (2007). Using Rubrics to Assess the Development of CDIO Syllabus Personal and Professional Skills and Attributes at the 2.x.x Level. *Global Journal of Engineering. Education, 11*(2), 117-122.

Bollela, V. R., Gabarra, M. H., da Costa, C., & Lima, R. C. (2009). Students and tutors' social representations of assessment in problem-based learning tutorials supporting change. *BMC Med Educ, 9*, 30. doi: 10.1186/1472-6920-9-30

Bonwell, C.C., & Eisen, J.A. (1991). Active Learning: Creating Excitement in the Classroom (A.-E. H. E. R. N. Washington, Trans.): George Washington University.

Boud, D. , & Feletti, G. (1998). *The Challenge of Problem-Based Learning* (2nd ed.): Kogan Page.

Crawley, E., Malmqvist, J., Ostlund, S., & Brodeur, D. . (2007). *Rethinking Engineering Education: The CDIO Approach* (1 ed.): Springer.

Crowe, Alison, Dirks, Clarissa, & Wenderoth, Mary Pat. (2008). Biology in Bloom: Implementing Bloom's Taxonomy to Enhance Student Learning in Biology. *CBE-Life Sciences Education, 7*(4), 368-381. doi: 10.1187/cbe.08-05-0024

Drake, J.R. (2012). A Critical Analysis of Active Learning and an Alternative Pedagogical Framework for Introductory Information Systems Courses. *Information Technology Education: Innovations in Practice, 11*, 39-52.

Felder, R. M., & Brent, R. (2009). Active Learning : An Introduction. *ASQ Higher Education Brief, 2*(4), 5.

Gallagher, S.A., Sher, B.T., Stepien, W.J., & Workman, D. (1995). Implementing Problem-Based Learning in Science Classrooms. *School Science and Mathematics*, 136–146. doi: 10.1111/j.1949-8594.1995.tb15748.x

Gokhale, A.A. (1995). Collaborative Learning Enhances Critical Thinking *Journal of Technology Education, 7*(1).

Hamzah, M.S.G., & Abdullah, S.K. (2009). Generic Skills in Personnel Development. *European Journal of Social Sciences, 11*(4), 684-689.

Hart, D. (1994). *Authentic Assessment: A Handbook for Educators*: Addison-Wesley.

Hmelo-Silver, Cindy. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review, 16*(3), 235-266. doi: 10.1023/B:EDPR.0000034022.16470.f3

Jideani, V. A., & Jideani, I. A. (2012). Alignment of Assessment Objectives with Instructional Objectives Using Revised Bloom's Taxonomy—The Case for Food Science and Technology Education. *Journal of Food Science Education, 11*(3), 34-42. doi: 10.1111/j.1541-4329.2012.00141.x

Joy, Simy, & Kolb, David A. (2009). Are there cultural differences in learning style? *International Journal of Intercultural Relations, 33*(1), 69-85. doi: http://dx.doi.org/10.1016/j.ijintrel.2008.11.002

Knight, P. (2001). Formative and Summative, Criterion and Norm-referenced Assessment. http://www.bioscience.heacademy.ac.uk/ftp/Resources/gc/assess07Keyconcepts%5B1%5D.pdf

Kolb, David A, Boyatzis, Richard E, & Mainemelis, Charalampos. (2001). Experiential learning theory: Previous research and new directions. *Perspectives on thinking, learning, and cognitive styles, 1*, 227-247.

Kolb, David A. (1984). *Experiential learning : experience as the source of learning and development*: Englewood Cliffs, N.J. ; London : Prentice-Hall, 1984.

Macdonald, R., & Savin-Baden, M. (2004). A Briefing on Assessment in Problem-based Learning. from The Higher Education Academy http://www.heacademy.ac.uk/assets/documents/resources/resourcedatabase/id349_A_Briefing_on_Assessment_in_Problembased_Learning.pdf

Masek, A., & Yamin, S. (2010). Problem based learning: Adapting model of monitoring and assessment towards changing to student centered learning. *Journal of Technical Education and Training, 2*(1), 12.

Mcdonald, Ranald. (2005). Assessment Strategies for Enquiry and Problem-Based Learning. *2*.

Meier, Sherry L., Hovde, Robert L., & Meier, Ronald L. (1996). Problem Solving: Teachers' Perceptions, Content Area Models, and Interdisciplinary Connections. *School Science and Mathematics, 96*(5), 230-237. doi: 10.1111/j.1949-8594.1996.tb10234.x

Moy, Janelle. (1999). The impact of generic competencies on workplace performance: Review of research.

NCVER, National Centre for Vocational Research. (2003). Defining Generic Skills.

Novak, Joseph.D. (1990). Concept mapping: A useful tool for science education. *Journal of Research in Science Teaching, 27*(10), 937–949. doi: 10.1002/tea.3660271003

Nur Sofurah Mohd Faiz, N. S., Mamat, N., Mohamed, M., Sulong, M. S., & Burhannuddin, M. F. (2008). Perceptions and Acceptance Towards PBL Approach: A Case Study on Technical & Vocational Students. *Proceedings Paris International Conference on Education, Economy and Society*, 6.

Ozbicakci, S., Bilik, O., & Intepeler, S. S. (2012). Assessment of goals in problem-based learning. *Nurse Educ Today, 32*(8), e79-82. doi: 10.1016/j.nedt.2012.03.017

Panitz, T. (1996). A Definition of Collaborative vs Cooperative Learning. Retrieved from http://www.londonmet.ac.uk/deliberations/ website: http://www.londonmet.ac.uk/deliberations/collaborative-learning/panitz-paper.cfm

Papinczak, T., Young, L., & Groves, M. (2007). Peer assessment in problem-based learning: a qualitative study. *Adv Health Sci Educ Theory Pract, 12*(2), 169-186. doi: 10.1007/s10459-005-5046-6

Paul, M. (2010). *How to organize the transition from a traditional curriculum to a PBL curriculum* doi:10.1093/acprof:oso/9780199583447.001.0001

Prince, Michael. (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education, 93*(3), 223-231.

Savin-Baden, M. (2000). *Problem-based Learning in Higher Education : Untold Stories*: The Society for Research into Higher Education & Open University Press.

Smith, K.A., Sheppard, S. D., Johnson, D. W., & Johnson, R. T. (2005). Pedagogies of Engagement: Classroom-Based Practices. *Journal of Engineering Education, 94*(1), 1-15.

Tabbron, G., & Yang, J. (1997). The interaction between technical and vocational education and training (TVET) and economic development in advanced countries. *International Journal of Educational Development, 17*(3), 323-334. doi: Doi 10.1016/S0738-0593(96)00072-7

Tai, G. X. L., & Yeuen, M. C. (2007). Authentic assessment strategies in problem based learning. *Australian Society for Computers in Learning in Tertiary Education*.

Tchudi, Stephen, & Lafer, S. (1996). *The interdisciplinary teacher's handbook: integrated teaching across the curriculum*: Boynton/Cook Publishers.

UNESCO. (2012). Transforming Technical and Vocational Education and Training Building skills for work and life (pp. 28). 7, place de Fontenoy, 75352 Paris 07 SP, France: United Nations Educational, Scientific and Cultural Organization.

Upadhyay, S. K., Bhandary, S., & Ghimire, S. R. (2011). Validating a problem-based learning process assessment tool. *Med Educ*, *45*(11), 1151-1152. doi: 10.1111/j.1365-2923.2011.04123.x

Ward, J.D. (1998). *Teaching strategies for family and consumer science: Student achievement in problem-based learning versus lecture-based instruction.* Unpublished master's thesis, Appalachian State University, Boone, NC.

Ward, J.D., & Lee, C.L. (2002). A Review of Problem-Based Learning. *Journal of Family and Consumer Sciences Education, 20*(1), 16-26.

Young, J., & Chapman, E. (2010). Generic Competency Frameworks: A Brief Historical Overview. *Education Research and Perspectives, 37*(1), 24.

Zulkifli Mohd Nopiah, Nuryazmin Ahmat Zainuri, Izamarlina Asshaari, Haliza Othman, Shahrum Abdullah. (2009). <Improving Generic Skills Among Engineering Students Through Problem Based Learning in Statistics Engineering Course.pdf>. *European Journal of Scientific Research, 33*(2), 270-278.

Assessing final year engineering projects

Prue Howard [a] *, Mohammad G Rasul [b], Fons Nouwens [c]

[a]*Central Queensland University, Bruce Highway, Rockhampton 4702,Australia*
[b]*Central Queensland University, Bruce Highway, Rockhampton 4702,Australia*
[c]*Central Queensland University, Bruce Highway, Rockhampton 4702,Australia*

Abstract

The final year engineering project (FYEP) is the culminating learning experience for students within professional engineering programs. The project requires students to demonstrate that they can integrate knowledge, skills and professional graduate attributes developed during the program, and perform at a standard expected of graduates. Australian national accreditation guidelines require engineering programs to show that students are capable of personally conducting and managing an engineering project to achieve a substantial outcome to professional standards. However, in Australia, there is no clear definition of the educational purposes and expectations of FYEPs, including the assessment requirements, particularly in the key area of research skills. This paper will outline the issues and concerns currently voiced within the educational community, and outline a current project that is aiming to address these issues.

Keywords: assessment, engineering, accreditation,AQF, threshold learning outcomes

1. Introduction

Within the Australian context of engineering education, Engineering Schools in Australia are facing several urgent challenges, making sure that:

1. the requirements of the FYEPs meet the Australian Qualifications Framework AQF8 definition of research outcomes for Honours Bachelor Degrees and accreditation requirements for professional project research in AQF7 Bachelor Degrees
2. the FYEPs provides students with opportunities to provide evidence of Threshold Learning Outcomes for Engineering
3. assessment practices are reliable and valid and suitable for the accreditation of engineering programs from Engineers Australia and to meet Washington Accord requirements.
4. industry perceptions are adequately addressed, because these capstone experiences often open employment doors for graduates.

The FYEP is capstone learning experience for any engineering program. It is the one common experience or course that all engineering students complete, no matter in which institution they study. The project gives students the opportunity to demonstrate that they can perform as a graduate engineer on an engineering project. It requires all the aspects of a project based experience, in that they must solve an open ended, ill defined problem, integrate content knowledge, communicate with a range of people in both oral and written form, and behave as a professional. While these outcomes are what are desired from a PBL experience, they are also the capabilities required by international engineering accreditation agreements such as the Washington Accord, International Engineering Alliance 2009, to which Engineers Australia are a founding signatory.

In 2012, there are two new requirements for Final Year Projects:

1. An AQF8 requirement that it demonstrates research capability: *Graduates of a Bachelor Honours Degree will have coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines and knowledge of research principles and methods* (AQF, 2013) and skills to design and use research in projects.
2. A requirement to satisfy the draft Threshold Learning Outcomes that will be used by Tertiary Education Quality Standards Agency (TEQSA). Graduates must demonstrate an ability to: *Identify needs, context and systems of problems; Apply problem solving, design and decision making methodologies; Apply abstraction and modelling skills; Communicate and coordinate proficiently; and Manage Self in the short and long term*.

In 2010, the Australian Learning and Teaching Council (ALTC) supported a project to develop Learning and Teaching Standards for engineering (Wright *et al.*, 2010). This project consulted with academics, industry, graduates and students and Engineers Australia to identify Threshold Learning Outcomes (TLOs) for Engineering that defined minimum program top-level

* Dr Prue Howard. Tel.: +6-17-4930-9730
E-mail address: p.howard@cqu.edu.au

discipline skills, knowledge and professional capabilities expected of a graduate. The project clustered many indicators of competency into five major domains of competency that provide a framework for holistic curriculum development and assessment. These five TLOs provide an integrating framework that defines what graduates are expected to know, understand and be able to do as a result of their learning. The report suggests that *as part of a final year project, a student approaching a complex problem … will use the full range of outcomes (page 7).* The report also suggested that *there is little common dialogue across institutions and industry regarding standards.* What was very evident, however, was the importance of establishing clear standards (page 9). The report also rose as an issue for standards and assessment the need to find ways of providing evidence of achievement of TLOs in ways that all stakeholders could accept with confidence.

To provide a reliable indicator of student capability and program quality and standards, FYEPs must be coherent, valid and reliable instruments for student assessment and program evaluation. An investigation of assessment practices in FYEPs at Australian and New Zealand universities (Rasul *at el.* 2010) was conducted by some of the authors of this paper. It identified concerns with assessment of complex projects and difficulties in developing assessment criteria, assessment of individuals in team's projects, alignment of industry and academic interests in projects, difficulty in scoping projects and assigning appropriate projects to students and workload and availability of staff for project supervision. There is very little dialogue or collaboration between institutions, each dealt with problems in different ways. The lack of standard assessment invites benchmarking to identify good practice.

2. What is known

A recent ALTC funded project considered development of assessment practices for project based subjects that were team based (Howard & Eliot 2012). While this project dealt mainly with the issues of assessing individuals within teams, it also uncovered the underlying issues of staff attempting to assess students against learning outcomes, when the project is the context for learning. In this study one of the problems identified was whether the academic was attempting to assess the product or the learning itself.

Other studies reveal large variations in the way FYEPs are managed and assessed (Jawitz *et al.*, 2002). Oehlers (2006) identifies some of the challenges in assessing engineering project work. The issues he identifies are consistent with those found elsewhere for final year projects in disciplines other than engineering (Tribe and Tribe, 1988; Webster *et al.*, 2000).

The literature shows a broad range of practices and a lack of consensus about what constitutes a legitimate assessment task, what assessment criteria are appropriate or what level of formative assessment and support is legitimate (Armstrong *et al.*, 2005; Oehlers, 2006; Blicblau, 2006; Seidel *et al.*, 2006; Kuisma, 2007; Mills, 2007; Beckerleg and Collins, 2007; Rasul *et al.*, 2009; Cochrane *et al.*, 2009; Valderrama *et al.*, 2009; Rasul *et al.*, 2010; Rasul *et al.*, 2012). Much of the variation appears to result from insufficient preparation of and academic isolation of academic supervisors, a lack of general discussion about project expectations among faculty and lack of agreement about issues of both educational task and whole of program design and assessment. Eliot et al 2012 and Howard & Eliot 2012 also identified a lack of understanding by academic staff about alignment of learning outcomes and assessment as an issue in project based subjects.

A review of ALTC projects identified development work in areas related to assessment and group work, but not to final year or capstone courses. ALTC projects included work on assessing individual work in teams (ALTC 2009, priority project: Assessing individual learning in teams: developing an assessment model for practice based curricula in engineering), assessing group work (ALTC 2005, priority project: Assessing group work in media and communications) and on supporting peer assessment and review in large group work projects (ALTC 2006, priority project: Supporting student peer assessment and review in large group work projects). Such work will be useful where programs require that capstone FYEPs involve student collaboration, but many engineering programs in various universities require individual project work. Other ALTC projects supported development of tools for competency and skills assessment (ALTC 2007, competitive grants project: The development of an undergraduate nursing competencies assessment tool for use across Australian Universities; ALTC 2006, priority project: LinuxGym—A sustainable and easy-to-use automated developmental assessment tool for computer scripting skills). Again, this work may be drawn on in developing criteria frameworks for capstone assessment of competencies and skills, but the work does not address specific requirements of project assessment. Further study is essential to address the problems identified above.

3. Identifying the problem

Reliable and valid assessment practices are central to the integrity of the qualifications offered at universities and are thus a legitimate focus for quality assurance. Well designed and implemented, FYEPs can provide a robust vehicle for assessing attainment of threshold learning outcomes by students who are about to graduate, as well as provide evidence of the effectiveness and standards of a program of study for accreditation.

Accreditation requirements (Engineers Australia, G02Rev2. 2008) "expect that programs will employ at least one major engineering project experience, which draws on technical knowledge and skills, problem solving capabilities and design skills from several parts of the program and incorporate broad contextual considerations as part of the full lifecycle.", but currently there is no measure or guarantee of consistency as mentioned earlier. Such projects provide a vehicle for benchmarking program outputs nationally and internationally. However actual practices vary greatly between institutions and little work has been found that seeks to identify good practice. Discussions between higher education institutions and Engineers Australia, have identified several concerns and issues.

The problem to be addressed is how to develop consistency in the standard and outcomes of FYEP in Australia while maintaining the independence required within an individual program of study.

4. What is proposed

This project can effect positive change in learning and teaching in the discipline, profession, sector, nationally and internationally. The project team intend to address these concerns and issues by surveying current practice in FYEP and developing a community of FYEP practice to identify good practice guidelines and test resources for students, supervisors and coordinators. Surveys and development of guidelines and resources will be focused on the following areas:

- Support for Students: While the curriculum may scaffold development of students' capacity to undertake projects through project-based learning (PBL) and work-integrated learning (WIL), the FYEP represents a major extension of expectations regarding a student's capacity to conduct a project. In identifying resources that can be made available to help students manage their projects, questions about the appropriate balance between support and exposure to real-life complexity need to be addressed. Student guidelines and resources will be produced and tested.
- Preparation for Academic Staff: Final year project assessment is vulnerable to variation in the quality of supervision because a large number of projects need supervision each year requiring many academics, each of whom may advise students differently about project expectations. Identification and description of good practice would provide academic supervisors with resources for induction and staff development and clear expectations about the supervisor's role.
- Preparation of Industry Clients and Supervisors: Many universities promote industry involvement in FYEPs. Industry partners provide valuable exposure to professional practice and gain access to prospective graduates. However industry client's expectations about project outcomes may not align well with academic requirements. Industry projects may also involve intellectual property and confidentiality issues that require sound guidelines. Authoritative explanatory guidelines would assist industry partners to understand the educational context and expectations of FYEPs.
- Selection of Projects: The kind of project a student selects can influence a student's learning. Routine projects may not provide scope for students to demonstrate high levels of professional capability and obtain a high grade. There is debate about what kinds of FYEPs are acceptable and the kinds of professional competence that projects should allow students to demonstrate. A survey to identify good practice and develop guidelines about project selection would assist students and supervisors identify appropriate projects. Such questions affect evaluation of program standards so they would involve some elaboration of accreditation requirements and consultation with Engineers Australia.
- Project Assessment: Assessment can take into account different elements (e.g. supervisor's report, technical report, design portfolio, journal, poster, oral presentations, weightings for technical quality, etc). The criteria for grading projects use various rubrics that influence assessment and benchmarking processes. In relation to holistic assessment of Threshold Learning Outcomes, the particular issue in assessment is the balance between the product or outcome of the project on the one hand, and on each student's professional development as an engineer on the other. Best practice guidelines for assessment would provide a basis for more consistent application of standards.
- Standards for Research: Accreditation guidelines require students to demonstrate information literacy and basic research skills, however the AQF framework distinguishes between an AQF7 Bachelor Degree and an AQF8 Bachelor Honours Degree while allowing the Honours program to be embedded in a four year Bachelor Degree. The AQF distinguishes between AQF7 and AQF8 in terms of project work, research skills but accreditation would require completion of projects in the AQF7 Bachelor Degree. There is also a need to define the both the purpose and standard of project research required by accreditation for both AQF7 and AQF8. Is the aim of research to provide a vehicle for developing professional skills, or is the research intended to produce significant new knowledge? Broad academic consensus is required to ensure that students are treated equitably fairly.
- Standards for Project Reports: A standard outcome of an FYEP is an extended report or portfolio. It is important that students receive clear advice about requirements and an appropriate level of support in preparing their reports because the FYEP report will often be the first extended report students have prepared. If project assessment is based on report moderation (i.e. only on the evidence presented by students in the report), supervisors and moderators also need shared expectations for assessment, and supervisors must advise students of these expectations. A survey of current good practice and articulation of discipline guidelines would assist both students and supervisors.
- Curriculum Integration: Recent consultations to develop the set of Threshold Learning Outcomes for engineering provides a more holistic framework that can be used to interrogate learning outcomes specified for project courses, and for how a program of study is designed to lead students to successful completion of projects and to become capable and confident professionals. This project would provide a vehicle institutions could use to review curriculum in terms of the TLOs.
- Coordination and Supervision of Projects: A FYEP coordinator is usually appointed to coordinate academic administration of all project courses within a program or discipline area. Then for each project, an academic project

supervisor provides learning support and contributes to assessment. Projects are individualised, time intensive and involve workload formulas different from those used in other courses. Some students and projects require more time than others. Students need access to staff who are prepared to and capable of providing the required project support. An understanding of current staff development practices for undergraduate project supervision skills is required to inform the development of best practice guidelines for staff development to promote quality assessment.

These issues and concerns must be addressed to achieve consistency and fairness in formative assessment and support for students, valid and reliable summative assessment of prospective graduates, and program standards within and across engineering programs in any faculty of any university. The resulting guidelines and processes from this project could serve as a benchmarking tool for all engineering schools.

5. What has been done

A pilot project was conducted in Australia to investigate how final year projects are assessed currently. A small number of institutions took part in the study. The literature indicated that a broad range of universities offering FYEP courses identified a number of key issues of concern relating to teaching and learning practices. In particular, a general lack of consensus on teaching and learning methodologies and project scoping came to the forefront. "Discussions among practitioners involved in scholarship in engineering education indicate that universities are failing to use FYEPs effectively, partly because FYEPs are different from most other undergraduate courses, and FYEP coordinators are professionally isolated". Such issues may "result from insufficient preparation of and academic isolation of academic supervisors, a lack of general discussion about project expectations among faculty and lack of agreement about issues of educational task design and assessment". (Rasul, et al (2009).

The pilot report concluded that there are major discrepancies between the institutions in the way that they assess FYEP.

6. Conclusions

The FYEP is the student work that can be used to demonstrate that the AQF8 requirements and Threshold Learning Outcomes have been met by a professional engineering degree program. Currently there are no national guidelines or specified requirements for institutions to use in ensuring that their FYEP meet these requirements to ensure consistency throughout the nation.

Previous studies have identified issues with the knowledge and understanding of some academic staff to allow them to separate the product of the project from the learning within the project. Other studies have identified the issues relating to inconsistency both within and across institutions.

A project has been approved and funded to investigate the current assessment practices within FYEP across Australia and to develop guidelines for staff and students. This project is being funded by the Office of Learning and Teaching (OLT) and is supported through the reference group by Engineers Australia. The project will survey and critically review coordination, supervision and assessment practices of FYEPs in universities and disciplines of engineering, and then develop and promote an FYEP assessment model and benchmarking guidelines to assist engineering disciplines to improve FYEP assessment. This project is running over two years and started in January 2013.

At this stage, the project is collecting data from across the country on how the projects are set up, where they come from (industry or acadaemia), how they are supervised, what percentage of study load is attributed, how they are assessed, how they are moderated and what level of research is included. The major point of interest will be to compare how individual institutions use the project to demonstrate how individual students can apply the knowledge and skills developed over the course of their study.

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7. References

AQF2013, Australian Qualifications Framework, Published by Australian Qualifications Framework Council, Second edition January 2013, http://www.aqf.edu.au

Armstrong, P. J., Kee, R. J., Kenny, R. G., and Cunningham, G. (2005), A CDIO approach to the final year capstone, *Paper presented at the 1st Annual CDIO Conference*, 7-8 June 2005, Queen's University, Kingston, Ontario, Canada.

Beckerleg, M., and Collins, J. (2007), Producing research from undergraduate projects. In H. Sondergaard & R. Hadgraft (Eds.), *Proceedings of the 18th Conference of the Australian Association for Engineering Education, 9–13 December 2007*, Melbourne, Australia.

Blicblau, A. S. (2006), Capstone Portfolios for Learning and Evaluation, in G. Rowe & G. Reid (Eds.), *Proceedings of the 17th Annual Conference of the Australasian Association for Engineering Education, 10–13 December 2006*, Auckland, New Zealand.

Cochrane, S., Goh, S. and Ku, H. (2009), An investigation into the application of research strategies in the final year engineering and surveying projects, in C. Kestell, S. Grainger and J. Cheung (Eds.), *Proceedings of the 20th Annual Conference of the Australasian Association for Engineering Education, 6-9 December 2009,* Adelaide, Australia.

Dong, C. (2012), Assessment mechanical engineering final year projects using Fuzzy multi-attribute utility theory, *Research and Development in Higher Education, Vol 43, 23-30*.

Eliot, M., Howard, P., Nouwens, F.,et al. 2012 *Developing a Conceptual Model for the Effective Assessment of Individual Student Learning in Team-Based Subjects*, Australasian Journal of Engineering Education Vol 18, Number 1, pp105 – 112, 2012

Engineers Australia (2006), *PO5 rev1: Engineers Australia National Generic Competency Standards—Stage 1 Competency Standards for Professional Engineers.*

Engineers Australia (2011), *Stage 1 Competency Standard for Professional Engineer.* Canberra Australia.

Howard, P & Eliot, M. (2012) *A Framework for Assessing Individuals who Learn in a Team Environment* Proceedings of the 23nd Annual Conference for the Australasian Association for Engineering Education. Melbourne, Australia, 5-8 Dec 2012

International Engineering Alliance (2009), *Washington Accord,* International Engineering Alliance, http://www.ieagreements.org/Washington-Accord/, Accessed 23June 2009.

Jawitz, J., Shay, S., and Moore, R. (2002), Management and assessment of final year projects in engineering, *International Journal of Engineering Education, 18*(4), 472–478.

Kuisma, R. (2007), Portfolio assessment of an undergraduate group project, *Assessment & Evaluation in Higher Education, 32*(5), 557–569.

Mills, J. E. (2007), Multiple assessment strategies for capstone civil engineering class design project, in H. Sondergaard & R. Hadgraft (Eds.), *Proceedings of the 18th Conference of the Australian Association for Engineering Education, 9–13 December 2007,* Melbourne, Australia.

Oehlers, D. J. (2006), Sequential assessment of engineering design projects at university level. *European Journal of Engineering Education, 31*(4), 487–495.

Rasul, M.G., Nouwens, F., Martin, F., Greensill, C., Singh, D., Kestell, C. and Hadgraft, R. (2009), Good practice guidelines for managing, supervising and assessing final year engineering projects, in C. Kestell, S. Grainger and J. Cheung (Eds.), *Proceedings of the 20th Annual Conference of the Australasian Association for Engineering Education, 6-9 December 2009,* Adelaide, Australia.

Rasul, M.G., Nouwens, F., Martin, F. and Greensill, C. (2010), Benchmarking in assessment of final year engineering projects, *CQUniversity Internal learning and Teaching Report*, Australia.

Rasul, M.G, Nouwens, F., Swift, R., Martin, F. and Greensill, C. (2012), Assessment of Final Year Engineering Projects: A Pilot Investigation on Issues and Best Practice, In M.G. Rasul (edit), *Developments in Engineering Education Standards: Advanced Curriculum Innovations, Chapter 5, 80-104,* IGI Global Publisher, USA. ISBN 13: 978-1-46660-951-8.

Seidel, R. H. A., Tedford, J. D., and Islam, M. A. (2006), Assessment of the effectiveness of team and project based learning in engineering education. In G. Rowe & G. Reid (Eds.), *Proceedings of the 17th Annual Conference of the Australasian Association for Engineering Education, 10–13 December 2006*, Auckland, New Zealand.

Tribe, D., and Tribe, A. (1988), Assessing law students: lectures attitude and practices, *Assessment and Evaluation in Higher Education, 13*(3), 83–93.

Valderrama, E., Rullan, M., Sanchez, F., Pons, J., Mans, C., Gine, F., Jimenez, L. and Peig, E. (2009), Guidelines for the final year project assessment in engineering, *The 39th ASEE/IEEE Frontiers in Education Conference, Session M2J*.

Webster, F., Pepper, D., and Jenkins, A. (2000), Assessing the undergraduate dissertation, *Assessment and Evaluation in Higher Education, 25*(1), 71–80.

Wright, S., Hadgraft, R., and Cameron, I. (2010), *Engineering and ICT Academic Standards Statement*, Learning and Teaching Academic Standards Project, Australian Learning & Teaching Council, Department of Education, Employment and Workplace Relations, SydneyStrunk, W., Jr., & White, E. B. (1979). *The elements of style.* (3rd ed.). New York: Macmillan, (Chapter 4).

The Impact of PBL Training on Legal Professions

Antoni Font [a] *, Gisela Cebrián [b]

[a]*Professor of Law, University of Barcelona, Barcelona 08034, Spain*
[b]*PhD student, University of Southampton, Southampton SO17 1BJ, United Kingdom*

Abstract

This paper presents a research conducted with law graduates that took part in problem based learning (PBL) courses during their university education, their university mentors and employers. The research focused on identifying the aspects of PBL training that contributed to the adaptation of graduates to the workplace. The analysis concludes that the use of PBL enhanced graduates' methodological approach to work, the development of autonomy and the experience gained in dealing with situations closed to the professional reality. PBL contributed to the development of skills that are seen as necessary for the professional practice such as teamwork and communication, and removed cultural barriers that inhibit the professional development of graduates in the initial stages of their professional practice.

Keywords: competences, problem-based learning, vocational training, professional practice

1. A new framework of relations: 'the knowledge economy'

Changes in economic and social models have taken place over the last decades. These changes have led to the creation of educational frameworks that focus on identifying the competences that individuals need to develop at a personal and professional level. The concept of the knowledge society was introduced by sociology. It calls for the transformation of educational frameworks, claiming for a paradigm shift (Castells, 2004). This paradigm shift involves new challenges and requirements. The current globalised world presents a context where knowledge generation increases exponentially and spreads rapidly and widely (Isusi, 2003). In this context university students and graduates are required to think more deeply (Cowan, 2006) and to develop professional skills, which operate as prerequisites for employability (Nixon, 2006). Therefore university education needs to deal with the challenge of developing high order skills amongst students that can be transferred to the workplace (Rué, 2008).

The new educational paradigm of competences is the result of adjusting professional training frameworks to the requirements of current society, based on the idea of the knowledge economy (Isusi, 2003). Changes in the socioeconomic models have led to a lack of qualified workforce. New patterns of employment and the organisation of work have led to an increasing demand of high order skills. Current employees need to be able to rapidly adapt to changes, be flexible, deploy a wide range of skills and manage their personal and professional development effectively. Hence higher education institutions need to create collaborative schemes with business to generate knowledge and learning in the workplace. For law education, the paradigm of competences points also to teaching and learning at a higher cognitive level. Higher education role is to help students become independent learners and develop critical thinking, but without forgetting the need to develop other type of skills such as instrumental and interpersonal. The model of collaboration between universities and business should be orientated towards a clinical and preclinical training, where universities, the administration, business, student bodies and professional official bodies participate in the elaboration and implementation of training programmes equally. This would make the process more comprehensive and ensure that students acquire a set of skills and professional competences relevant to the workplace.

2. The discourse on competences

The main aim of this study was to research the ability of higher education institutions to facilitate the transition from formal education to the workplace in the context of law studies. The premise of this study was that competence-based education involves a cultural change. This cultural change cannot be reached without an inclusive rationale (Bruner, 1990, 2002) and a coherent methodological approach. The introduction of the concept of competence in higher education needs to overcome certain barriers such as its rationale, as its origins are rooted in the industrial vocational training. Initially the discourse of competences emerged from behavioural approaches to training. This discourse focused on the actions that employees have to take in their workplace, but without paying attention to their understanding of these actions (Rue, 2007). The recent call for high order skills in the context of the 'knowledge economy' faces the risk of moving back to uncritical behaviourist training frameworks. However this can be overcome by redefining the concept of competence (Rue, 2007). According to Winterton *et al.* (2006) the concept of competence involves: knowledge; skills; intellectual and attitudinal abilities; and the reflective thinking of individuals.

The concept of competence is complex and it is often seen as difficult to deal with. It integrates different elements that operate independently but are closely related. All these elements - knowledge, skills, attitudes and emotions - affect the behaviour of people in action. Therefore, competences are developed and learned in formal and informal settings. Competences

* Antoni Font. Tel.: +34 93 4029055
E-mail address: afont@ub.edu

tend to be developed in long lapses of time, becoming a dynamic concept, which changes and evolves with the activity and in context (Eraut, 1994). From the perspective of the workplace, competences are related to higher levels of performance and according to Winterton (2006) are potentially transferable to other situations. The fusion between both learning contexts, formal and informal, allows the incorporation and recognition of all the skills that an individual has developed in formal and informal learning environments. Learning outcomes can be defined based on functional alignment (Biggs, 2003). This enables to establish a better relation between training and employment. It also allows exploring the synergy between formal and experiential learning to foster professional competences. Therefore this leads to meeting the demands of the new 'knowledge economy' and professional development. However the competence-based framework and therefore the idea of a paradigm shift in education mean challenging current and deeply ingrained teaching routines that are socially shared. A more holistic approach to teaching and learning is needed that enables moving from transmission of knowledge to more student-centred approaches and learning-in-action.

3. Problem based learning in legal education

Problem based learning (PBL) is seen as a philosophy and a teaching and learning method (Rue *et. al.*, 2011). According to Engel (1997) current students will be active professionals in the coming years. They will need to practice in an era characterised by uncertainty and rapid and constant change (Schön, 1995). Therefore self-directed and lifelong learning throughout their life will be crucial in order to deal with rapid changing situations and uncertainty in the workplace. A set of competences and specific skills such as flexibility and dealing with uncertainty ought to be developed. Recent research (Rue *et al.*, 2010) shows that students involved in PBL models performed better on self-regulation and linking theory to practice than students involved in traditional teaching and learning styles. For legal education, PBL methodology is considered key in the acquisition of competences and the development of skills. This has been evidenced by several studies, since PBL aims match with those of legal education (Cruickshank, 1996). For Pérez Lledó (2006) it is necessary to train first-class law professionals, technically competent lawyers that have the skills to use law knowledge skilfully and are able to juridically argue a range of possible solutions. However this law professional, besides being 'technically competent' needs to take moral responsibility in the usage and application of law for social purposes. Considering the aims of legal education, Pérez Lledó (2006) suggests three different levels of training: the cognitive level, which refers to knowledge acquisition; the methodological level, which refers to skills and techniques required for argumentation; and a higher level related to political and moral legal education, which allows the fulfilment of critical and constructive ends. However a certain consensus exists on the ends of training programmes, no consensus exists on the exact meaning of both a lawyer and being competent. As a starting point it is necessary to define a framework of professional competences of lawyers. This is a difficult task especially in relation to the specific competences, because the law profession offers many shades and contrasts. However it could be argued that the central activity of the lawyer is counselling, mediating conflicts and represent outsider' interests. To establish the professional competences of a lawyer rigorously (Eraut, 1994) a set of the most influential normative and official documents have been reviewed and analysed. A comparison of the competences contained in these documents (MacCrate Report, 1992; Proyecto Tuning America Latina, 2004-2008; Decreto de acceso a la Abogacía, 2011) and other relevant publications that consider the conditions of employment and the workplace (Esteves, 2011; Prospects, 2012; TARGETjobs, 2012; Kane, 2012) is shown in Table 1:

Table 1. Competences reported in official documents and publications

	Documents analysed							
Competences reported in the documents analysed	**Esteves**	**Prospects**	**Kane top ten**	**TARGETjobs**	**Decreto acceso**	**MacCrate Report**	**Proyecto Tuning América Latina**	**Total**
1. Knowledge	5	3	7	0	10	5	4	34
2. Representation of outsiders' interests	6	0	5	0	7	7	8	33
3. Management	6	0	9	6	3	2	0	26
4. Communication	2	3	10	3	2	3	1	24
5. Teamwork	5	0	5	5	2	1	2	20
6. Factual and legal research	0	1	3	0	1	9	1	15
7. Decision-making	5	0	1	0	1	6	2	15
8. Analysis	0	1	4	1	3	2	3	14
9. Information technologies	2	0	8	0	1	0	1	12
10. Planning	0	0	5	4	0	3	0	12
11. Ethics	0	0	2	0	3	5	1	11
12. Argumentation	0	2	2	1	1	1	4	11
13. Application of law and	0	1	2	0	1	1	5	10

knowledge								
14. Advice	2	0	0	0	2	5	0	9
15. Evaluation	0	1	1	0	2	3	1	8
16. Problem-solving	0	1	1	2	2	1	1	8
17. Second language	5	0	0	0	1	0	1	7
18. Creativity	1	2	0	1	0	2	1	7
19. Negotiation	0	0	0	2	0	4	0	6
20. Leadership	1	0	0	3	1	0	1	6
21. Business orientation	1	0	2	2	1	0	0	6
22. Critical thinking	0	1	1	0	2	1	1	6
23. Motivation	3	0	0	2	0	0	0	5
24. Professional improvement	0	0	1	0	1	1	2	5
25. Writing of documents	0	2	2	0	0	0	1	5
26. Diagnosis	0	0	0	0	2	3	0	5
27. Ability to relate and synthesise	0	0	1	0	0	1	3	5
28. Interpretation	0	1	1	0	0	0	3	5
29. Social state of law	0	0	0	0	1	1	2	4
30. Alternative resolution of conflicts	0	0	0	0	1	1	1	3
31. Autonomy	2	0	0	0	0	1	0	3
32. Justice	0	0	0	0	0	1	2	3
33. Loyalty	0	0	0	1	0	0	1	2
34. Confidence	0	1	0	1	0	0	0	2
35. Attention to diversity	0	0	0	0	0	1	0	1
36. Flexibility	0	0	0	0	0	1	0	1
37. Work under pressure	0	0	0	1	0	0	0	1
Total	46	20	73	35	51	72	53	350

Values = number of detected occurrences for each of the documents in the header

Table 1 shows the competences of a legal professional required by different official documents. Table 1 also shows the number of times that these competences are reported in each document. The total number of occurrences in the documents analysed allows drawing a quantitative comparison of the importance assigned to different competences. Knowledge of the standards and principles that compose the legal system is the most cited competence. Representation of outsiders' interest, management, communication and teamwork are the following most cited competences in the documents. The other ten more cited competences are those that refer to organisational, instrumental and interpersonal aspects of the profession. The only purely cognitive competence that appears in the first half of the list is the ability to analyse. The rest of the cognitive skills appear in the second half of the list, which also includes skills that are purely professional. Loyalty, confidence, attention to diversity, flexibility and work under pressure are the less cited competences in the documents.

The lawyer profession can be defined according to two variables. A fixed variable characterised by the development of cognitive skills and an independent variable related to specific activities. The lawyer is in charge of generating solutions placed within legislative frameworks. This requires the construction of a discourse based on facts and often conflicting interests. Nevertheless lawyers need to articulate juridical arguments with consistent narratives.

For the former positivist mentality, dominant in legal thought in Spain, it can be seen as surprising that law learning can take place in an inductive way. This is because deductive reasoning from the general rule is a more common approach to the lawyer practice. This methodological approach is characterised by the extraction of concepts through the analysis of linguistics of legal statements and their logical relationships. This allows building a neutral argument that often excludes empirical, sociological and moral considerations (Pérez Lledó, 2006). However it should be noted that the professional work of the lawyer is more complex and involves both deduction and induction. PBL has the advantage of connecting these processes with the professional reality, thereby facilitating the development of different types of reasoning. This in turn increases the motivation to learn and fosters long-term acquisition of knowledge and skills.

4. Analysis of the impact of PBL education in legal education

A document analysis of official documents and reports on professional competences of lawyers has been conducted and presented in the previous section. Documents from USA and UK have been analysed due to the lack of sources of this type. In 2011 in Spain, a regulatory decree to the lawyer profession was published. This document develops a list of the competences that graduates ought to develop during law studies. Previously (2004-2008) the Tuning project for Latin America produced a similar list. In the USA, the *MacCrate Report* (1992) represented one of the first attempts to define a set of competences for law graduates.

The research presented in this paper is based on the study of a group of twelve law graduates that finished their studies between 2005 and 2010, a group of five human resources managers - employers and a group of five university mentors. The data collected is based on semi-structured interviews conducted with graduates (10), mentors (5) and employers (5), and two life stories of graduates. The semi-structured interviews were conducted between 2010 and 2012. Four focus-groups were also conducted, two with legal practitioners (judges and lawyers) and two with graduates that took part in PBL courses. The interviews conducted with employers seek to identify the type of professional, with what professional competences, they are seeking to employ.

This sample was selected because these three groups are directly involved in the initial training of law professionals. The aim of this research was to identify the views of these three different groups on professional competences and the role of PBL in fostering these amongst law students. Employers and graduates working in different firms with different legal focuses and forms of professional practice were selected to have a heterogeneous sample.

The data analysis has allowed the exploration of how PBL training influences graduates in their adaptation to the professional practice and the workplace. The data analysis explored common difficulties identified by graduates in their initial stages of the professional practice and the skills and competences developed through their engagement in PBL courses.

Table 2. Sample law graduates

Name	Age	Gender	Graduate	Membership professional body	Sector level	Studies father	Studies mother	Grade entry	Graduate grade	Work experience
Z.A.	1978	Male	2007	2011	High	University	University	5,58	7	Internship no legal
X.B.	1981	Male	2006	2010	Medium	University	Primary level	5,75	7,4	Internship no legal
M.M.	1980	Female	2009	2009	Medium	Primary level	Primary level	5,34	7	Internship no legal
R.G.	1982	Female	2005	2005	Medium-high	University	Primary level	8,3	8,4	Internship no legal
S.T.	1982	Male	2005	2007	Medium	Secondary	Primary level	7,92	8,2	Internship
P.A.	1979	Male	2008	2009	Medium	University	Secondary	6,71	6,5	No legal
M.P.	1985	Female	2010	2010	High	University	University	8,1	8	Internship no legal
Y.M.	1984	Female	2007	2011	Medium	University	University	8,16	8,6	Internship no legal
B.Q.	1986	Female	2009	2009	Medium-high	University	University	7,32	7,7	Internship no legal
A.S.	1984	Male	2010	2010	Medium-high	Professional training	Secondary	5,48	7,2	Internship no legal
J.K.	1985	Male	2008	2010	Medium-high	University	Primary	6,9	8,6	Internship no legal
R.S.	1984	Male	2009	2010	Medium	Secondary	Secondary	6,7	7,2	Official

Table 3.

Sample employers

Name	Membership professional body
M.M.M.	2000
B.B.B.	1998
R.R.R.	1987
Q.Q.Q.	1976
Z.Z.Z.	1962
A.A.A.	1962
S.S.S.	1989
P.P.P.	2007
X.X.X.	2001
Y.Y.Y.	1995

The interviews and focus groups were transcribed into word files and analysed using a qualitative thematic analysis approach. The application TAMS Analyzer was used as a support tool for this task. A set of categories emerged from the data, these categories, which corresponded to skills and competences, were named similarly to the competences reported in the documents analysed as part of this study. All transcripts were validated by the interviewees. The information obtained was broken down into units of information that make sense for themselves and that anyone can understand and interpret in a similar way. Each unit of information was codified, codes were then grouped into categories, and categories. The information obtained in the interviews with graduates was contrasted with the views of mentors and the framework of a lawyer that emerged from the interviews with employers, those responsible for human resources. A questionnaire was also distributed amongst twenty-five graduates between 2005 and 2010. This has helped identify the benefits and deficits of the university training, and also the difficulties faced by graduates in their initial stages of professional practice and adaptation to the workplace.

1.1. The working conditions in the legal office

A legal office can be understood as the work environment in which the professional activity of the lawyer is developed. The legal office is an organisation where materials and human resources execute a task through the development of a professional activity. This office is placed in the services sector. Human capital and trust between people are key features of the legal office. Law firms are often hierarchical organisations with a large delegation of functions. The hierarchy, autonomy and interpersonal relationships amongst members of the organisation, and between them and the audience are intrinsic elements of the development of a novel lawyer. The framework described influences the exercise of the professional activity. The agenda of a law firm is also influenced by two other important factors: customer dependence and time constraints i.e. pressure to meet certain deadlines.

In the interviews conducted with employers and graduates the problems and difficulties faced by new professionals in their adaptation to the workplace were identified. Human resources managers stressed that one of the main issues was related to graduates difficulties to adapt to this new working environment. Many of these attitudes could be rooted to a paternalistic approach of university studies in Spain. This presents difficulties in becoming independent learners, both in terms of the way ‘to go’ in the resolution of cases, and how to work on them to anticipate possible consequences. The dominance of the university approach in the workplace determines that some graduates that recently joined a legal office are not aware of the risk they take in their work; they do not distinguish between the effort invested and the result obtained. Consequently they have difficulties to understand and accept their own failures as part of their own learning process and adaptation to the workplace. This creates frustration and problems of adaptation that are clearly reflected in the views of both employers and graduates.

With regards to the development of the professional task, participants stressed that one of the most important difficulty is teamwork, including interpersonal communication. It results difficult to share information, as colleagues tend to be defensive and show awe at their senior peers and the Administration of Justice. They have panic to make any involuntary mistakes, as error is interpreted as punishment. For this reason graduates tend to wait to receive orders from their superiors. This issue is also reflected in job advertisements, law firms when defining the profile of the job candidate ask for ‘pro-active’ or ‘independent’ professionals. This research also showed a strong embarrassment of new graduates to ask questions or express doubts or ignorance, because of their fear in showing their weaknesses and emotions. The aspects related to the management of their own work are also emphasised by employers as a significant difficulty, which graduates tend to agree.

Table 4. Key challenges identified by graduates

At the beginning of my career ...	▪ I was not used to have a schedule. ▪ I was not used to prioritise tasks. ▪ I was not used to have orders from superiors. ▪ I was not used to work under pressure. ▪ I didn’t know the starting point of a case. ▪ I didn’t dare to ask to colleagues for doubts or fear to avoid showing ignorance.

In reference to the key characteristics of a professional that is ‘technically competent’ (Pérez Lledó, 2006) according to the employers interviewed a law professional has to meet three criteria: specialised knowledge; strategic thinking and an ethical commitment. Regarding knowledge, employers stressed that professional work requires specialisation and teamwork with leadership capabilities, a functional division and a great personal interdependence. Conversely, employers emphasised that broad general knowledge of law and the general principles that govern both domestic and international legislation need to be emphasised as part of university education. However most of employers’ discussion was focused on strategic thinking. This involves the use of cognitive skills but also involves the deployment of interpersonal skills, where communication plays an important role. Negotiation, empathy and flexibility are competences highlighted as crucial to establish positive relationships with colleagues, customers and the judicial or administrative authorities. The orientation towards the costumer becomes one of the key features of the lawyer professional work. Instrumental skills such as mastery of a second language, ability to search for information or the use of information technologies are highly valued by employers.

Finally, it should be noted that the legal profession has become industrialised, the demand for legal services has increased exponentially and the customer increasingly focuses its attention on ex-ante action to prevent disputes (Van Bemmelen van Gent, 2012). This implies cooperation amongst lawyers and costumers to try to reach a solution. Therefore, some employers highlighted commitment as a significant attitude of the lawyer. This attitude connects with an axiological component, which can be assessed in accordance with ethical standards.

1.2. *The difficulties of graduates in adapting to the workplace*

Graduates considered that the difficulties they faced to adapt to the workplace had two main origins: deficits in their training and cultural aspects. Deficits in their training do not refer to theoretical knowledge, they refer to a lack of training in applied knowledge and further opportunities to apply the theoretical knowledge acquired. This was also identified in a study undertaken by AQU (2003), where the students surveyed considered the theoretical knowledge they had acquired through their higher education degrees exceeded its practical utility (AQU, 2003).

Table 5. Cross-tabulation of the competences identified by graduates and employers

Competences identified by graduates	Analysis	Application	Argumentation	Advice	Evaluation	Communication	Self-confidence	Creativity	Diagnosis	Flexibility	Management	Interpretation	Research	Leadership	Motivation	Negotiation	Critical thinking	Work schedule	Decision making	Writing of text	Represent the interests	Problem-solving	Synthesis	ADR	Technology	Teamwork	TOTAL
Analysis		1	3	1	1			1	3		1						2	1	2		1	2	3				22
Decision-making	2		2	2							1		1	1	2	1					4				1		17
Argumentation	3	1			1												2		2		1	2	3				15
Application	1		1	1	1	1		1				3					2				2		2				15
Evaluation	1	1	1					1	1	1			1								1	2		3			13
Critical thinking	2	2	2	2																	1	2	1				12
Motivation						1					2			1					2		3					3	12
Problem-solving	2		1		1			2	1								2							2			11
Communication		1					1				1				1					3	3					1	11
Diagnosis	3	1		1	1								1					1				2					10
Synthesis	2	2	3														1					1					9
Research					1				2		1							2	1		1				1		9
Creativity	1	1			1					1												3					7
Interpretation		3																									3
																											144
TOTAL	17	13	13	7	7	2	1	5	7	2	6	3	3	2	3	1	9	4	7	3	17	14	9	5	2	4	166

Values = Number of occurrences detected in the data analysed

Table 5 is a cross-tabulation of the competences identified by graduates (first column) and the competences identified by employers (first row). The values in Table 5 express the number of occurrences that one competence had with another in a unit of information.

Employers made reference to communication skills. On the other hand graduates expressed fears of being ridiculed. This issue prevents them to naturally interact within other colleagues and working groups, participate in public speeches or structured debates. This is a negative factor because it reduces their autonomy and inhibits their learning from and with others. In this sense, it is apparent the existence of a significant deficit in law education in the university context: the lack of orientation and guidance on know-how. However it should be noted that one of the main difficulties identified by interviewees is about the methodology and the organisation of work. Different levels of difficulty can be distinguished in this arena. A first level of difficulty is presented by those aspects that relate to the conditions and the organisation of work. A second level of difficulty is related to the relationship established with the customer, which embraces oral and writing communication skills and the management of emotions. The third level makes reference to strategic thinking, which comprises the whole reasoning process. Finally the ethics of the profession was also emphasised by employers and graduates. This does not correspond to a difficulty but mirrors the complexity of certain situations and actions undertaken in legal offices.

5. The contribution of PBL to the workplace adaptation

The results obtained can be classified into two major groups. One group refers to the development of cognitive skills that contribute to smooth the transition from university education to the workplace and the other group refers more specifically to the deployment of skills to do with the professional practice, which have been gained through higher education.

1.3. Cognitive skills

From a cognitive perspective employers emphasised the importance of strategic thinking. Moreover the graduates interviewed considered that PBL provided them with the opportunity to apply knowledge to solve real problems. Graduates explicitly identified gaining insights into tools to link theory and practice as a methodological aim of PBL. Graduates also emphasised the importance of the functionality of these tools, both in learning and in the professional practice. This refers to the ability to transfer knowledge from a sector to another. Therefore the development of high order skills was seen as a priority by graduates. PBL was stressed by graduates as a teaching and learning methodology that contributed to foster high order skills and the ability to work autonomously.

Referring to the process leading to the resolution of problems, interviewees highlighted several aspects that are worthy of consideration. Most of the graduates interviewed emphasised the role of PBL in assisting the diagnosis phase of the problem. PBL was seen also as an intrinsic contributor to learning to search for solutions and the solving process in itself. According to the graduates PBL provided tools to foster reasoning based on analysis, argumentation and interpretation. PBL also facilitated learning about decision-making on the basis of a range of possible solutions. PBL approach encouraged critical and divergent thinking. Graduates considered that PBL was useful to their further professional work.

1.4. Practical or specific professional skills

The graduates interviewed considered that PBL helped them develop a methodological understanding of legal processes that was very useful to their professional life. Graduates when asked about what were their memories of the major impacts of PBL had emphasised the approach and focus on real professional practice. Interviewees' responses differed when specifying the skills related to the approach to work. Some of them emphasised skills such as searching and managing information, with the search and analysis of jurisprudence as a predominant feature. Another feature highlighted by interviewees was the contribution that PBL had to the organisation of work. Having to execute different individual and group tasks such as the search of information, the elaboration of conceptual maps and reflective practice contributed to the organisation of work. Some of the graduates considered that they were organised in their work. Graduates stated that the ability to organise their work and tasks was enhanced because of their engagement in PBL courses.

Another key competence that emerged during the interviews was teamwork. The work of the lawyer is developed within teams, which are often interdisciplinary. By contrast, teamwork is uncommon in the context of higher education and students tend to refuse it because of previous negative experiences. Teamwork is a key feature of PBL, which represents an ideal space for future graduates to learn to work together and manage and resolve possible teamwork conflicts. These were aspects highlighted by all the graduates interviewed. In reference to teamwork it is necessary to emphasise two further aspects that emerged from the interviews with graduates. The first refers to the communicative competence and management of emotions, and the second refers to the coordination and leadership capabilities. Graduates interviewed recognised that they learned how to communicate within groups and to general public through PBL courses. In terms of communication and writing skills most of the interviewees stated that they had little opportunities to gain these skills through their university education, however PBL courses enabled them to gain communicative skills. To sum up Table 6 shows the results obtained in the questionnaire distributed amongst graduates. Table 6 presents the benefits that graduates emphasised they obtained through their engagement in PBL courses.

Table 6. Benefits obtained through engagement in PBL courses

	1	2	3	4
My engagement and experience through participating in PBL courses initially:				
It helped me plan the problem-solving approach and identify possible solutions for a professional case-study	0	0	6	18
It facilitated the task of teamwork with peers in a joint project	0	3	6	16
It gave me criteria and tools to know how to search for information	0	2	8	15
It allowed me to overcome difficulties of communication with peers, bosses and/or authorities	0	4	10	11
It taught me to think about different things/factors before making a decision	3	0	11	11
It helped me realise about my strengths and weaknesses	0	6	8	9
It made me realise about the importance of being independent	2	1	14	8
Number of students. Values: 1 = Strongly disagree; 2 = Disagree; 3 = Agree; 4 = Strongly agree.				

Table 6 shows the high value that graduates assign to PBL in the development of professional competences such as the ability to solve problems, communication, overcome difficulties, decision-making and teamwork. Therefore PBL has contributed to soften the transition from university to the workplace. PBL facilitates intellectual processes that are intrinsic of the professional practice of the lawyer.

6. Conclusions

From the analysis of the data obtained it can be concluded that PBL training has had a noticeable impact in three different arenas:

- In the approach to work
- In the personal autonomy
- In the approximation to the professional practice

In reference to the approach to work the graduates interviewed emphasised the methodological approach to the professional practice. The intellectual process that students follow when engaging in PBL processes is identical to the process used by practitioners in their professional duties. Thus it can be concluded that PBL is a methodological choice that favours and softens the transition from academia to the professional reality. Furthermore PBL offers them a reference model that students can apply to their professional practice afterwards.

Referring to personal autonomy graduates that had been involved in PBL acknowledged the need to take initiative and be autonomous in making decisions and judgements. They also acknowledged the need to be reflective and act according to their own judgement and the learning aims established. This fosters a more strategic way of working, which includes establishing aims, elaborating a work plan and evaluating the results obtained. Although respondents showed a high level of satisfaction in gaining professional competences through PBL, this strategy alone does not cover the diverse needs of training graduates. It should be noted that an explicit demand for training in this area currently exist.

PBL contributes to bridge the gap between theory and practice, approximating students to the professional reality. From the data analysed in this research four aspects can be identified where the incidence of PBL has been relevant and plausible. The first aspect refers to organisational aspects: the need for planning and having a shared agenda; prioritising; time management; and work under pressure amongst others. These are issues that have been experienced at some point by all students in PBL. A second aspect is based on reproducing the intellectual process involved in working as a lawyer through PBL groups. Bring a problematical situation to the students, in which students learn inductively forces them to engage in a strategic process of analysis, diagnosis, argumentation and decision making. This process in turn involves the development of critical and divergent thinking. This provides the case for a situation very closed to the real professional practice. It fosters reflective practice and learning on what are the strategies used and how professionals deal with challenging situations in practice. A third aspect is the development of instrumental skills such as the search, management and selection of information, especially jurisprudence, which some university graduates only have had the opportunity to do this practice in PBL courses. Finally, work in small groups has become the environment where students have had the opportunity to learn to manage their emotions, develop shared leadership, interpersonal and conflict resolution competences.

References

AQU (2003), *Educació superior i treball a Catalunya. Barcelona*: AQU.
Biggs, J., (2003), *Teaching for Quality learning at university,* Buckinghamshire: Society for Research into higher Education and Open University Press.
Boud, D.; Solomon, N. (2001), *Work-Based Learning: A New Higher Education?,* Florence, KY: Taylor & Francis.
Barrows, H.S.; Tamblyn, R.M. (1980), *Problem based learning: an approach to medical education*, New York: Springer.
Bruner, J., (2002), *Making stories, law, literature, life*, New Cork, Farrar, Strauss, Giroux.

Castells, M., (2004), *La era de la información: economía, sociedad y cultura*, Madrid: Alianza Ed.
Cowan, J., (2006), *On becoming an Innovative University Teacher, Reflection in Action*, second edition, Berkshire: Open University Press.
Cruickshank, D.A. (1986), "Problem based learning in legal education", en Cruickshank (ed.), *Teaching Lawyers Skills*. London: Butterworths.
Engel, C.E. (1997), "Not just a method but a way of learning", en Boud, D. & Feletti, G (ed.), *The Challenge of Problem based Learning*, 2ª ed., London Stirling: Kogan Page.
Eraut, M. (1994), *Developing Professional Knowledge and Competence*, London: Falmer.
Esteves, M.P., "¿Planificando con competencias o competencias para una planificación?", comunicación presentada en el IV Congreso de Innovación Docente en Ciencias Jurídicas (Valladolid, 2011), inédito.
Isusi, I. (coord., 2003), "Le développment des compétences dans las PME" Observatoire des PME européennes, Informe, IKEI, Instituto Vasco de Estudios e Investigación, en: http://ec.europa.eu/enterprise/enterprise_policy/analysis/doc/smes_observatory_2003_report1_fr.pdf., consulta el día 11 de julio de 2012.
Kane, S. (2012): "Top Ten Legal Skills". http://legalcareers.about.com/od/legalcareerbasics/tp/legal-Skills.htm. (Consulta: 08/08/2012).
Lipman, M., *Pensamiento complejo y educación*. Madrid 1998: Ediciones de la Torre.
MacCrate Report (1992). *Legal Education and Professional Development*. American Bar Association.
Nixon, I.; Smith, K.; Stafford, R.; Camm, S. (2006), *Work-based learning. Illuminating the higher education landscape. Final Report.* Heslington: The Higher Education Academy, a http://www.heacademy.ac.uk , consulta el día 30 de agosto de 2012.
Pérez Lledó, J.A. (2006), *La enseñanza del Derecho. Dos modelos y una propuesta*. Lima: Palestra.
Prospects (2012), the UK's official graduate careers website. Law. Your Skills http://www.prospects.ac.uk/options_law_your_skills.htm. (Consulta 08/08/2012).
Proyecto *Tuning America Latina* (2004-2008). Derecho. http://tuning.unideusto.org/tuningal/index.php option=contento&task=view&id=235&Itemid=265. (Consulta 08/08/2012).
Real Decreto 775/2011, de 3 de junio, por el que se aprueba el Reglamento de la Ley 34/2006, de 30 de octubre, sobre el acceso a las profesiones de Abogado y Procurador de los Tribunales (Boletín Oficial del Estado número 143, de 16 de junio).
Rué, J., (2007), *Enseñar en la Universidad*, Madrid: Narcea.
Rué, J. et. al. (2010), "Towards an Understanding of Quality in Higher Education: The ELQ/AQA08 Model as an Evaluation Tool", en *Quality in Higher Education* 16 (3), 285 295.
Rué, J. et. al. (2011), "El ABP, un enfoque estratégico para la formación en Educación Superior. Aportaciones de un análisis de la formación en Derecho", *REDU, Revista de Docencia Universitaria,* Vol.9 (1), Enero-Abril 2011, 25-44, consulta el día 9 de agosto de 2012 en http://redaberta.usc.es/redu/index.php/REDU/issue/view/63 .
Schön, D.A. (1995), "Educating Reflective Legal Practicioner", *2 Clinical L. Rev. 231 1995-1996,* 231-250.
TARGETjobs (2012). "The top 10 skills that'll get you a job when you graduate". http://targetjobs.co.uk/career-sectores/law-solicitors/applications-and-interviews/what-skills-don-law-firms-look-for-when-reguera. (Consulta 08/08/2012).
Van Bemmelen van Gent, Ernst, (2012) "Legal Education: A New Paradigm", en *Bynkershoek Law Review*, http://ssrn.com/abstract=1273683 (consulta 15/02/2013).
Westera, W., (2001), "Competences in education: a confusion of tongues", en *Journal of Curriculum Studies*, vol. 33, 1, January, pp. 75-88.
Winterton, Delamare & Stringfellow, (2006), *Typology of Knowledge, Skills and Competences: clarification of the concept and prototype*, CEDEFOP Reference Series, 64, Luxemburg, Office for Official Publications of the European Communities, (140 págs). http://www.cedefop.europa.eu/en/publications/13031.aspx, consulta el día 11 de julio de 2012.

An assessment model for individuals within PBL

Prue Howard [a] *, Matt Eliot [b]

[a]Central Queensland University, Bruce Highways, Rockhampton 4702, Australia
[b]Central Queensland University, Bruce Highways, Rockhampton 4702, Australia

Abstract

The inherent complexity of team-based learning environments creates ambiguity for academic staff and students alike in terms of learning goals and the production of evidence of individual student learning. This five-institution research project developed a conceptual model for effective assessment of individual student learning in this highly collaborative setting. This model was then workshopped and piloted at 4 institutions within Australia. This paper reports on the research design of this project, and discusses the outcomes of the pilot use of the model, as well as identifying issues for ongoing research.

Keywords: *Project Based Learning, assessment, rubrics, constructive alignment, learning outcomes*

1. Introduction

A student's grades in a particular team-based subject should reflect what she or he has learned as an individual within the team context, often framed in terms of the learning outcomes embedded in the course design. The need to assess individual student learning is often at odds, however, with the realities of the assessment process. Many instructors work within constraints such as student numbers, workload pressures, and limited expertise in assessment itself. As a result, individual students within engineering team-based project subjects are often been assigned a grade heavily influenced by the team's project deliverables. This use of team-created deliverables as indicators of individual student learning has multiple potential problems. For example, a less-than-successful project often results in reduced grades for its individual members, which can be both unfair to students and professionally unethical for academics. The conditions and actions that constitute project "failure" are often the source of significant learning. As assessment drives behaviour, the desire for higher grades influences the team dynamics resulting in an emphasis on project outcomes rather than individual learning, potentially degrading collaborative learning (Johnson and Johnson 1998, Johnson, Johnson and Smith 1998)

In addition to discerning individual student learning, assessment practices themselves are used inconsistently in engineering team-based subjects. The quantitative assessment methods generally used in engineering subjects assess specific, technical content knowledge, which tends to require right or wrong processes and answers. The majority of engineering academics and industry professionals understand and are more comfortable with quantitative assessment methods. Qualitative assessment methods, however, are more suited than quantitative methods in assessing students' engagement with graduate attributes in engineering project-based learning (PBL) subjects, particularly in terms of the broader, professional, context-dependent skills developed in this pedagogical approach. The recent ALTC-supported project "Engineers for the Future" (King, 2008) recommends the development of best-practice engineering education to promote student learning and deliver intended graduate outcomes. This project follows the 1996 report "Changing the Culture (IEAust, 1996), which first highlighted the need for change to an outcomes-based engineering education system in Australia. Experience with accreditation teams shows their mistrust of qualitative assessment, with teams often commenting that qualitative assessment is subjective and is therefore not a valid or reliable method of assessment in engineering. While this is anecdotal evidence, the situation has happened in Australia enough times for the problem to be recognised. Yet it is these qualitative methods that assess critical engineering skills, such as design thinking.

The aim of this project was to develop a summative assessment model that allowed the assessment of students as individuals, when they do their learning in a team environment. The model should capture both technical/scientific knowledge, as well as those higher order processes that are the hallmark of team-based project-oriented subjects – higher order processes such as design thinking, communication, and teamwork.

This paper gives an overview of the entire project which took two years. The early stages of the project have been reported on in publications such as Eliot and Howard et al 2012, Eliot and Howard 2011, and Howard and Eliot 2011. This paper concentrates on the later stages of the project, where a pilot was conducted to trial the assessment model developed by this project, and the overall findings of those pilots.

* Dr Prue Howard. Tel.: +61-749-309-730
E-mail address: p.howard@cqu.edu.au

2. Methodology and methods

This research and development project is founded on a synthesis of design research (Brown, 1992; Collins, Joseph, and Bielaczyc, 2004) and Grounded Theory inquiry (Strauss and Corbin, 1998; Charmaz, 2006). Design research offers an epistemological approach to investigating theoretical constructions of learning and teaching in the "real world" context of the working classroom. Grounded Theory, a research paradigm founded in the social science context, offers the opportunity to explore participants' lived experience for the purposes of generating theory – in our case, a model of effective assessment of individual students' learning in team-based pedagogies such as PBL. For this project, effective assessment meant a confidence by the assessor that the learning of the individual was being assessed, not the outcome of the team. Additionally effective meant that the desired aspect was being assessed. That is the learning of the individual not the quality or correctness of the product or artefact produced by the team.

Drawing from these methodological traditions, the research team has pursued the following activities:

1. Conducted interviews and focus groups with academic staff and students at the five member institutions.
2. Analysed the interview transcripts using qualitative data analysis methods to reveal current assessment practices, common and unique understandings of the purpose of assessment, and perceived challenges or limitations.
3. Constructed a conceptual model illustrating the essential features of effective assessment of individual student learning in the team-based, project-based setting.
4. Implemented a pilot study of the strategic assessment framework based on the conceptual model at the Australian member institutions to explore the feasibility and relevance of the model itself.

The method was based on a list of three initial assumption articulated by the project team:

- Assessment is a significant 'driver' of student learning.
- Collaborative learning emphasizes not just learning content but also the reacculturation of learners as they enter the community of practice of engineering (Bruffee, 1999). It therefore focuses on how the world view of students changes as this reacculturation takes place and assessing this change requires holistic assessment.
- The role of assessment in a learner-centred approach like PBL is somewhat different from that in more teacher-centred approaches. While most students (and many staff) see assessment only as a tool for measuring how much they have learned (assessment of learning), in PBL there is a strong emphasis on using assessment to support and direct student learning (assessment for learning) (Weimer, 2002).

As described in Howard & Eliot, (2011), a conceptual framework was developed and articulated. This model is shown in Figure 1 below.

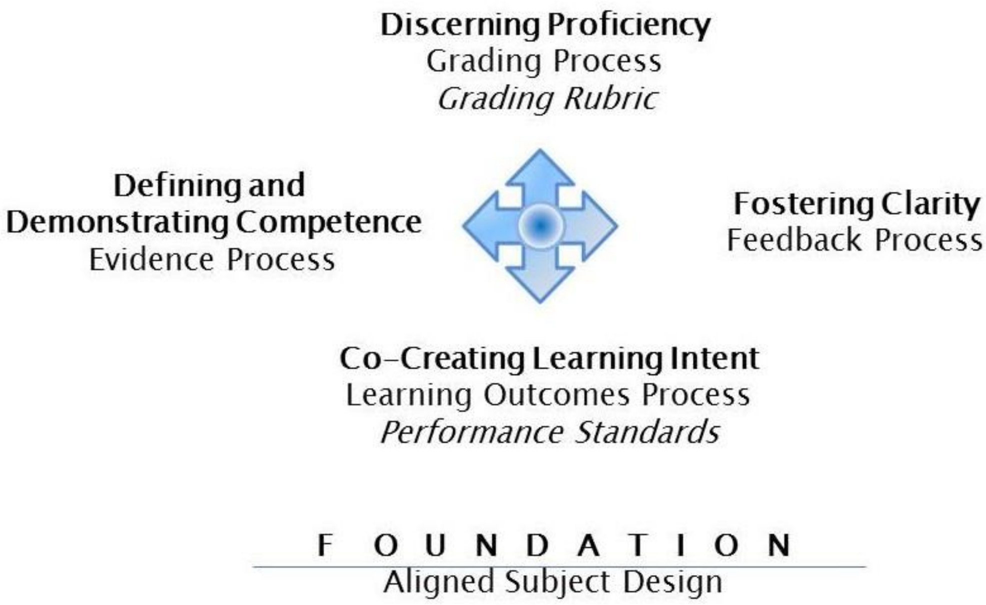

Figure 1. Conceptual Model

The research team presented this conceptual model in conference workshops, at symposia, and in informal presentations and conversations (Eliot, M. and Howard, P., 2011 and Eliot, Howard, et al 2012). During the process of moving from the conceptual model to the strategic assessment framework, we derived a number of founding principles to guide the implementation of the framework in varying institutional contexts.

As a group, we understood that assessment is a significant 'driver' of student learning as a student's perception of the importance of a given subject activity can be directly related to the weighting the activity is given in the assessment process (Black and William, 1998). At the same time, our experience suggests team-based pedagogies, such as project- and problem-based learning, offer a new and perhaps confusing context for students because opportunities for individual students to demonstrate their own learning are often limited when team products form the basis for final grades. In addition, the complexity of team products and the team focus on receiving the highest grade can both limit individual students' input into and control over final version of the product

3. The guiding principles

Reflecting on these and similar observations, as well as the preliminary data analysis findings, (presented in Eliot Howard et al, 2012) the research team developed the following principles to support the adaptation and implementation of the strategic assessment framework at multiple institutions for the Term 2 2011 pilots:

1. Assessment is a significant 'driver' of student learning as students' perception of the importance of a given subject activity can be directly related to the weighting the activity is given in the assessment process.
2. Quality of assessment depends on the alignment of learning outcomes, teaching and learning activities, and assessment items.
3. Learning outcomes are the intellectual contract between staff and students and act as the organizing structure for assessment.
4. Students' understanding of the connection between learning outcomes, teaching and learning activities, and evidence of learning is developed through ongoing dialogue between students and staff. This ongoing dialogue is vital for optimal student learning and performance,
5. Learning outcomes within a single subject vary in importance and impact, especially when considered within the larger stream of degree-related subjects.
6. Learning activities must provide multiple opportunities for individuals to gather personal evidence of learning against the subject learning outcomes.
7. Team products, such as reports and presentations, are not evidence of individual student learning.
8. Learning teams at the university should differ significantly from working teams in industry in relation to values, practices, and expected outcomes.
9. An individual students' final grade should represent their final state of learning as opposed to indications of learning at various points during the term.

The model was then implemented in four pilot trials at the participant institutions in term 2 of 2012.

4. The pilot

The pilot participants were teaching Engineering subjects, each of which involved a significant team project. The research team delivered an introductory workshop to train the participant academic staff for the Term 2 pilots. While the strategic assessment framework made sense to the research team, the pilot was expected to shed light on "naïve" participant's ability to engage with the framework, and integrate the processes within their individual contexts. Contexts were varied even within an individual institution, where some participants were offering totally project-based and hence team-based subjects, while others were delivering team-based projects as a part of a subject. For this reason, the research team members took a mentoring role during these pilots.

The participants were asked to use a final portfolio of evidence as the assessment item for the project work, and mark with two documents as a common basis for using the framework. The portfolio was to be a compilation of evidence produced by each student individually, and required the student to demonstrate how they, as an individual, had met each of the learning outcomes, and to what level.

The documents were a "standards sheet" and a grading rubric. The standards sheet was a matrix of the learning outcomes and the range of expected student outcomes or standards. For each learning outcome, the participants were asked to articulate what would be expected from students for each standard or level of development of that learning outcome. The participants were free to determine how many levels of development would be articulated. Most chose 4, being; unacceptable, acceptable, good, and excellent.

The grading rubric then described how the final grade was determined from the range of evidenced levels of achievement of each of the learning outcomes. In some cases a grade of Pass required all learning outcomes to be met to an acceptable level, in others the requirement was different. However the participants had to decide on, and communicate to the students the process being used, prior to the start of term.

The pilots were conducted at four institutions with a range of participants, who had varying degrees of experience in education. Each participant was mentored by a member of the project team, and regular meetings were held between the mentor and the participant. At the end of the term, interviews were held with the participants by the project evaluator. The mentors as members of the research team provided their own observations to the project officer as part of the data gathering. This was done as a written reflective document as well as informal interviews.

5. Outcomes

Each phase of this multi-phase project revealed important information about the subjective and contextual factors affecting the design and implementation of processes for the effective assessment of individual students in team-based project-oriented classes. These findings emerged from many sources including research team discussions, formal analysis of interview transcripts, as well as anecdotes told by participants and colleagues during workshops, symposia, and informal conversations.

The following comments on the outcomes of the pilots, is based on the reflective observations of the mentors at the end of the project. Most of the participants in the trial felt that they could adapt the framework or elements of the framework and its associated tools to their own teaching even if they hadn't gotten it completely right in this first trial. It was a case of experiential learning for the participants. They had made mistakes and had some successes, and could adapt from those experiences.

Some of the issues that were observed were:

- The workload involved in applying this the first time was an issue. It required the participants to ensure that they did have alignment of the learning outcome, teaching and learning activities and the assessment. One of the main pieces of work requiring time was the participant actually articulating the standards of achievement for the learning outcomes.
- Although the model encourages negotiation with students in refining the criteria, standards and rubric, most participants appeared to have difficulty achieving student engagement of this kind. Institutional constraints such as the necessity to have subject outlines (including assessment details) finalized before the start of term made it difficult to make these discussions meaningful.

The specific observations were broken down into three main areas, content, process and context.

5.1. Content Considerations

There were a range of skills considered.

5.1.1. Assessing technical knowledge and skills

Team-based project subjects offer an important opportunity to combine both technical knowledge and professional skills within a single integrated learning environment. In terms of assessing technical knowledge, participants reported that written examinations were often seen as the exemplar method of assessment, although some participants also reviewed workbooks and reflective journals. Oral examinations were reported as offering a more comprehensive method for exploring the strengths and limits of a student's technical knowledge and skills.

5.1.2. Assessing professional knowledge and skills

In addition to technical knowledge and skills, participants reported taking professional knowledge and skills into consideration, such as teamwork, working with clients, and the ability to facilitate interactive presentations. Participants sought evidence of student professionalism in their documentation and presentations, by oral examination, and by direct observation of team interactions.

5.1.3. Assessing broad understanding

Student teams often break complex projects into subsections, with an individual student focusing on a single section. While there are many benefits to this approach, one obvious downside is that students may lack a holistic perspective and do not engage substantively with other aspects of the project which are vital to their overall learning. The term "broad understanding" here refers to an individual student's learning in the areas of the project outside of the specific section they themselves have focused on.

Participants reported that the assessment process was a primary incentive that can motivate students to build broad understanding in team-based project subjects. Participants reported instilling expectations for broad understanding from the beginning of the subject and using oral exams at the end of term to explore the multiple areas of a single project. It is important to note that while broad understanding was seen as important by participants, when pressed these participants were sometimes unable to describe concrete standards by which it could or should be measured.

Participants also reported that assessing for broad understanding was an effective way to identify those "passenger" students who have minimal input or engagement with the team project and rely on the other team members to complete it.

5.1.4. Assessing design thinking

For the purposes of this paper, design thinking is being defined as the chain of reasoning within individuals and team which leads from problem identification to solution development and evaluation. Participants in this research project sought to assess students' design thinking: 1) as a key engineering skill, 2) as a method for assessing multiple competencies including technical knowledge and skills, teamwork, and broad understanding, and 3) as a method for identifying passenger students. Participants reported that written evidence (such as a report or a written exam) was limited in its ability to reveal design thinking, with reflective journals offering at best a limited perspective. Several participants used oral examinations to explore and assess design thinking, often with an emphasis on exploring an individual student's understanding of key decision points in the design process.

5.2. Process Considerations

There were several processes considered..

5.2.1. Determining individual contributions to team deliverables

Participants in this study frequently described a need to determine which students worked on particular aspects of a team deliverable such as a report or a presentation. This was seen as an important aspect of assessing an individual student's learning. In addition, participants framed this need in terms of fairness for students, referring to it as a method for identifying passenger students.

To better determine an individual student's contributions to their team's deliverables, participants variously reported doing the following: direct observation of teams; supervisory meetings with teams; requiring explicit attribution in presentations and documents; requiring the submission of team meeting minutes; and creating "milestone" assignments throughout the term that could involve contributions from both individual students and their teams.

5.2.2. Assessing a team's dynamics and the impact on an individual student's learning

Participants in this study recognised that the quality of team interaction could have a significant impact on an individual student's learning. To better understand team "health", participants used direct observation, observation in supervisory meetings, and peer assessment to look for positive team interaction as well as power imbalances and significant differences in contribution.

5.2.3. Assessing nternational students

Participants expressed concerns about assessing international students within their subjects in terms of varying levels of English language skill, possibly mismatched expectations about classroom behaviour, the need for local knowledge (i.e., Australian standards), and prior experience with hands-on laboratory sessions. Participants varied in their response to these concerns, ranging from instructors holding international students to less rigorous standards to instructors expecting international students to demonstrate knowledge and skills at levels equal with domestic students. Many participants talking about this consideration, however, simply described the situation as "difficult" without articulating how they personally responded to it.

5.2.4. Use of formative assessment opportunities

Many participants in this project recognised that formative assessment opportunities offered at strategic points across the term were necessary to keep teams "on track" toward the completion of the team project with its embedded learning goals. Formative assessment opportunities included reports (such as design briefs or requirements reports), shorter written assignments (such as status reports) and presentations. A few participants used only summative assessment measures implemented at the end of term, suggesting they also offered students and teams verbal formative guidance throughout the term.

5.2.5. Assessing against learning outcomes/objectives

Participants varied widely in their experience of and engagement with assessing against learning outcomes. Some participants implied that the subject learning outcomes were tangential to their teaching and assessment practices. When discussing learning outcomes, participants also described some frustration with learning outcomes about professional skills, suggesting that there was a "mandate" to focus on the technical aspects of the subject. In addition, some participants reported uncertainty about their own interpretation of the learning outcomes, suggesting that taking a team teaching approach can create opportunities for instructors to refine their understandings of the learning outcomes through discussion with fellow instructors.

5.2.6. Balancing teaching and assessment

Several participants used language suggesting that teaching practices were separate from assessment practices. These participants reported that time they spent on assessment processes was reducing the time they could be delivering subject content.

5.3. Contextual Considerations

There were a range of contexts considered..

5.3.1. Number of students in a subject

Participants spoke about the relationship between subject enrolment and quality of assessment, suggesting that larger student numbers lead to both a decrease in the number of opportunities for students to present evidence of their learning and a decrease in the sophistication of the feedback being offered to students. In some cases, team interaction was seen as a corrective factor with the belief that team members can offer each other important and useful feedback in an ongoing manner throughout the term.

5.3.2. Number of academic staff involved in delivering a subject

Those participants who delivered their subjects as part of a teaching team report two considerations in terms of assessment in team-based subjects. One consideration was variability among team members in terms of experience with and understanding of the assessment practices within the subject. Where variability is great, the need to train the teaching team added to the overall workload for the subject. Another consideration reported was variability in the interpretation of student evidence within the teaching team. This consideration again addresses one difficulty in outcomes-based teaching in the teaching team context: building a shared understanding of 1) the learning outcomes themselves and 2) what counts as student evidence for mastering a particular outcome.

5.3.3. Familiarity with team based pedagogies

This project included participants who taught in dedicated team-based programs using Project Based Learning (PBL) as well as participants employing team-based formats within a more traditional lecture-based curriculum. Some participants in this project were relatively new to teaching team-based subjects while more experienced participants were mentoring instructors who were new to this teaching context. In both cases, participants spoke of the limitations of inexperience with the team-based context on assessment quality.

5.3.4. Familiarity with the subject

Similarly, participants reported that relative inexperience with a subject could affect the design and implementation of assessment items as well as interpretation of the resulting evidence. These preliminary findings illustrate the complexity of the assessment process for engineering instructors in the team-based setting: multiple types of learning to be assessed; an often limited understanding of both the assessment process and the team-based learning environment; and contextual considerations that affect participants' ability to engage in the assessment of student learning in team-based coursework.

6. Conclusions

AIn this project, researchers from five tertiary institutions investigated current practices for assessing individual student learning in team-based undergraduate engineering coursework and from this investigation constructed a strategic framework which effectively assessed individual student learning in the team context. Undergraduate engineering education is becoming increasingly outcomes-driven, as professional organisations seek to define the evolving skillset necessary to join the profession. While the assessment framework proved effective, a major finding of this project was a fundamental lack of knowledge in the pilot participants of this project regarding the functions and the affordances of learning outcomes in the engineering curriculum.

This complexity calls for greater theoretical understanding of this assessment context, including types of teaching practices that can result in greater clarity for instructors and students alike. The main observation was that this was indeed a paradigm change for some. The project's tools help them to formulate their goals but further training in techniques such as constructive alignment and greater familiarity with educational principles generally in the participating academics was needed to make sure the tools are implemented effectively. Each of the elements of the framework may have seemed straightforward to many engineering instructors when first described, but our pilot experience suggests that these instructors often lacked the ability to translate these elements into their teaching practice in concrete and constructive ways.

The findings to date suggest that each of the elements of the model may have seemed straightforward to many engineering instructors when first described, but these instructors often lacked the ability to translate these elements into their teaching practice in concrete and constructive ways. These instructors showed a difficulty in moving from a content based approach to an outcomes-based approach in education.

A full report of the findings can be seen in the final project report (Howard and Eliot, 2012)

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References

Black, P. and William, D., (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice,* vol. 5, 1998, pp. 7-74.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions. *Journal of the Learning Sciences*. 2(2), pp. 141-178.

Bruffee, K. (1999. *Collaborative Learning: Higher Education, Interdependence, and the Authority of Knowledge*. Baltimore: Johns Hopkins University Press.

Charmaz, K. (2006). *Constructing Grounded Theory*. Thousand Oaks, CA: Sage Publications.

Collins, A., Joseph, D. and Bielaczyc, K. (2004). Design Research: Theoretical and Methodological Issues. *Journal of the Learning Sciences*, 13(1), pp. 15- 42.

Eliot, M. and Howard, P. (2011). *Instructor's considerations for assessing individual students' learning in team-based coursework.* Proceedings of 2011 Australasian Association for Engineering Education Annual Conference. Fremantle, Australia.

Eliot, M., Howard, P.,Nouwens, A., Stojcevski, A., Mann, L., Prpic, J.K., Gabb, R., Venkatesan, A. & Kolmos, A. (2012). Developinga Conceptual Model for the Effective Assessment of Individual Student Learning in Team-Based Subjects. *Australasian Journal of Engineering Education*. 18(1): pp. 105-112.

Howard, P. and Eliot, M. (2012). *Assessing Individual Learning in Teams: Developing an Assessment Model for Practice-Based Curricula in Engineering Final Report 2012*, OLT

Howard, P. and Eliot, M. (2011). *A Strategic Framework: Assessing Individual Student Learning In Team-Based Subjects*, Proceedings of 3rd International Research Symposium on Problem-Based Learning. Coventry, England

IEAust., 1996, *Changing the Culture: Engineering Education into the Future*, Institution of Engineers, Australia, Canberra

Johnson, DW & Johnson, RT 1998, *Learning together and learning alone: Cooperative, competitive and individualistic learning* (5th ed.), Allyn & Bacon, Boston.

Johnson, D, Johnson, RT & Smith, KA 1998, *Active learning: Cooperation in the college classroom*, Interaction Book Company, Edina, MN.

King, R 2008, *Engineers for the Future: Addressing the supply and quantity of Australian engineering graduates for the 21st century,* Australian Council of Engineering Deans, Epping, NSW.

Strauss, A. and Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.* London: Sage.

Weimer, M.G. (2002) *Learner-Centred Teaching: Five key changes to practice*. San Francisco: Jossey-Bass.

Development and Delivery of the Appropriate Assessments Items for Power Systems Related PBL Subjects

Amanullah MTO[a] *, Alex Stojcevski[a]

[a]*Deakin University, Geelong Waurn Ponds Campus, Geelong,3220,Australia*

Abstract

Problem Based Learning (PBL) as a teaching method has been around for many years. It is one of the most effective ways of learning and teaching. It uses real world problems as a learning method and encourages learners to learn independently while a mentoring support is provided by the academic. However, various academic institutions develop the assessments items in many ways; the implementation and delivery become a challenge in ensuring the right assessment and implementation. This paper discusses some of the practical experiences of the development and delivery of the appropriate assessment items for power systems related PBL subjects.

Keywords: PBL, Assessments, Delivery, Power Systems

1. Introduction

PBL method has proven to be one of the most effective ways of learning particularly in engineering and medicine. However, many institutions in many countries still face challenges in developing the right assessment items for the right cohort of students. The core reason behind this is due to the lack of academics with the right skills and commitments. PBL delivery requires extra effort from the academics in ensuring students learn the desired knowledge within the specified time.

Many academics are not fully committed to PBL though the institution is committed to promote it. In most cases, academics do not receive the training when they join a new institute which promote PBL mode of delivery. It is important to understand various proven assessment strategies and adopt those in PBL subjects. Tai et al (2007) reported various categorizes on assessment strategies. According to them, content deals with the knowledge students acquire, while process focuses on the students' ability to apply knowledge and skill in problem-solving. Outcome assessments whereas involve the products students design that shows their combination of content and new applications of knowledge.

Tai et al (2007) also shared that PBL tends to require more of a focus on assessing process than on assessing content, yet obviously content knowledge is still important. Ultimately, we need to seek evidence that students possess the means to embrace situations faced by practitioners of their profession and are competent to know how to go about dealing with such situations. White (2001) talks in terms of rather than assessing the achievement of content oriented objectives, we need to assess achievement of process oriented objectives - those that relate to how practitioners of a discipline or profession think about and solve problems within a certain field.

The success of delivering an effective PBL subjects starts with the development of the right assessment items for the relevant subjects. This paper presents some of practical experiences of the authors in developing and delivering the various PBL based subjects in the area of power systems.

2. Developing the appropriate assessments items

As the industry evolves, it is critical that academic courses and programs are revised to suit the industry needs. Accordingly, many universities in Australia have started curriculum review. Being involved in the curriculum review process for a number of subjects, it was found that developing the right assessment items is extremely vital in ensuring the students acquire the right skills and knowledge. In developing Capstone Power and Control Design subject to be delivered in PBL structure, an industry survey was conducted inviting practicing engineers from various industries. It was proven to be very fruitful approach as practicing engineers provided very useful feedback for the contents and delivery approach. The subject was developed to ensure students can learn independently.

As per the G. Xiao-Lian Tai and M. Chan Yuen (2007), "Assessment is a complex field, and almost everybody has an opinion as to what should be done. In recent years, ideas such as authentic assessment, performance-based assessment, and portfolio assessment have received a lot of attention. The authors further stated "two of the defining characteristics of a PBL study unit

* Dr Aman Than Oo. Tel.: +613 52479216
E-mail address: aman.m@deakin.edu.au

are that both the content and the assessment be authentic. Authentic assessment is substantially different than traditional assessment that is based on objective and short answer questions. As students are responsible for their own learning in PBL setting, students learn self-reflection where they become proficient in assessing their own progression in learning and also peer-assessment on how to effectively provide constructive feedback to their peers." D. G. Moursund (2002) has shared to a more general asseesment practices: "Authentic assessments are generally categorized into Performance Assessment, Portfolio Assessment, Reflection and Self-Assessment. Performance Assessments test students' ability to apply acquired knowledge and skills in a variety of authentic contexts and work collaboratively to solve complex problems. Portfolio Assessment involves developing a portfolio that documents learning over time. Reflection and Self-Assessment requires students reflect and evaluate their own participation, learning progress, and products which are essential components of autonomous learning."

N. Hosseinzadeh (2009) systematically looked at the development strategy in power system analysis based on PBL learning methodology. For a subject in power system areas, projects were defined in the following areas;

- Modeling of power system components
- Load flow studies
- Fault studies
- Economic dispatch
- Load forecasting
- Power system planning
- Power system stability

This has given a solid foundation for the students who are required to analysis power system using industry based software/tools such as SINCAL. N. Hosseinzadeh (2009) also reported the following assessments components which were proven to be very effective.

- Project reports
- Reflective journal
- Workbook
- Mid-semester test
- Reflective paper
- Self-grade nomination
- Peer assessment

It is very interesting to note that there is a mid-semester test in this subject though it is a PBL based subjects. There were concern and discussion whether to include a test in a PBL subject. Nonetheless, assessment in PBL is very complex and it is continuous topic to be further discussed in various forums. From N. Hosseinzadeh (2009), it can be learnt that though PBL courses are offered in projects, a written test has proven to be very effective to assessment students individually.

As for the Capstone Power and Design subject, the assessment was based on the Portfolio submission. It includes reflective journal for each week, project report, workbook and Peer's evaluation report. Reflective Journal requires to reflect on the way the assigned project was conducted. Project report for each project was expected to be a technical report similar to a project report done by engineers in industries. Work Book, which included all the related work that students had done during the project time. Overall, the portfolio should demonstrate how the learning outcomes have been met and to what level, and be presented in the form of a technical report. The portfolio must include all pieces of work produced which the individual claims can demonstrate how they have met the learning objectives of the subject.

Students were asked to design a microgrid system for each typical university campuses. They were asked to investigate distributed generation including from the renewable energy sources. As the assessment item was developed in a very practical way, the student enjoyed it and was able to use all the skills they learnt in the earlier subjects.

3. Deliervy of appropriate assessment items

There were a number of challenges in delivering this subject in PBL mode as half of the students were in off campus or distance mode. More and more universities in Australia are offering their courses and programs in distance modes to attract working and mature aged students. Delivering subjects in PBL modes has proven to be extremely difficult. Nonetheless, the teams were carefully chosen to ensure each group has at least one distance or off campus students.

In addition to their prior knowledge, additional lectures were also delivered relevant to the topic. In some cases, practicing engineers were invited to deliver the lectures and the students found it very useful. This has also provided an opportunity for the staff and the students to develop more engagement with the industry. It was a single large project in which students have to look at various aspect of modern microgrid. The project was divided to look into the following subcategories with specific task:

Week 1: Introduction to Microgrid
Activity: Understanding Microgrid: find relevant literature on Microgrid
Week 2: Electricity Uses and Demand Assessment
Activity: Make demand assessment by identifying your assigned campus energy requirements
Week 3: Electricity Uses and Demand Assessment
Activity: Develop a Single line diagram model of your campus
Week 4: Energy Sources for a Microgrid System
Activity: Identifying various energy sources for your campus
Week 5: Mapping and System Layout
Activity: Develop conceptual model
Week 6: Mapping and System Layout
Activity: Develop Model
Week 7: Control Elements of a Microgrid
Activity: Identify control system requirements for an efficient Microgrid
Week 8: Control Elements of a Microgrid
Activity: Design control system for Microgrid
Week 9: Safety and protection
Activity: Identify relevant safety standard and procedures
Week 10: Demand Side Management
Activity: Develop methodology for demand management
Week 11: Portfolio Preparation
Activity: Prepare your portfolio
Week 12: Student Presentations
Activity: Submit and present your portfolio

With this clear guideline, students were able to execute the task successfully. Modern technologies such as skype were used to communicate with the distance students. Assessments were carried out based on a final portfolio report. Each individual student was asked to present about their finding. One to one interview was also carried to ensure each student within the team contributed as per their claim. This has proven to be very effective. In some cases, students could not even answer some of the basic questions though they claim to do their respective sections in the report.

4. Conclusion

The assessment in this particular subject was designed to ensure the subject learning outcomes are met. Engaging industry engineers in the development of the assessment was proven to be very useful as they could contributed in the development of the projects along with its respective assessment items. Though there were some challenges with the distant students, the overall delivery of the subject was very satisfactory. Being capstone subject, students were able to demonstrate all the knowledge and skills acquired in their earlier studies.

References

D. G. Moursund (2002). Project-based learning in an information technology environment. Eugene, OR: ISTE, 2002.

G. Xiao-Lian Tai and M. Chan Yuen (2007). Authentic assessment strategies in problem based learning. Proceedings of ASCILITE 2007, the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE), Singapore.

N. Hosseinzadeh, M. R. Hesamzadeh and S. Senini (2009). A Curriculum for Electrical Power Engineering based on Project Based Learning Philosophy. IEEE International Conference on Industrial Technology, ICIT'09, Gippsland, Melbourne, Australia.

Tai, Gillian Xiao-Lian and Yuen, May Chan (2007). Authentic assessment strategies in problem based learning. Proceedings ASCILITE Singaore, Singapre 983-993.

White, H. (2001). Problem based learning' Speaking of Teaching. Stanford University Newsletter on Teaching 11 (1).

From Conventional to Non-conventional Laboratory: Electrical Engineering Students' Perceptions

Nur Ayuni Shamsul Bahri[a]*, Naziha Ahmad Azli[b], Narina Abu Samah[c]

[a]Nur Ayuni Shamsul Bahri, Centre of Engineering Education, Universiti Teknologi Malaysia, Malaysia
[b]Naziha Ahmad Azli,Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Malaysia
[c]Narina Abu Samah, Faculty of Education, Universiti Teknologi Malaysia,Malaysia

Abstract

Since 2007, the curriculum of a Bachelor of Engineering (Electrical) program offered at Universiti Teknologi Malaysia (UTM) has included a laboratory course which is designed to be problem or project based. This is in comparison to the previous conduct of the same laboratory that is procedural based. With the former, the active learning approach has provided the students with more opportunities to explore and solve a given problem or project in a team and devising their own experimental procedure instead of carrying out the tasks of a given experiment in a procedural manner as instructed in a laboratory handout. To date no proper study has been made in assessing the impact of this new laboratory approach on the students themselves. This paper presents the analysis made on the effect of the laboratory course on the students that is based on a sample of students' opinions and perceptions. The results of the analysis have indicated that the non-conventional laboratory course introduced in the Bachelor of Engineering (Electrical) program is well accepted by the students and has brought positive effects not only on the students' learning but also on developing various skills that are important for graduating engineers.

Keywords: Laboratory, problem-based, project-based

1. Introduction

Practical or technical skill is one of the crucial skills in engineering sectors. Engineering itself is a practical discipline that needs the "hand-on practice" as a key to understand and solve some unpredictable real world problems. Thus, in ensuring that the graduating engineers possess this skill, laboratory courses have always been included in any engineering curriculum design whether as a stand-alone course or embedded in the relevant engineering courses. Besides, ABET (2012) has clearly stated in its program outcomes 3(b) which is the need for engineering programs to demonstrate that their students attain to design and conduct experiments as well as to analyze and interpret data. This outcome justifies the need for multidisciplinary skills such as practical skill, team working and problem solving skill among engineering students upon graduation which can be successfully developed through laboratory practice. Thus the importance of a laboratory course and its advantages in enhancing the skills and knowledge of engineering students cannot be denied.

Through laboratory courses, students can transfer and practice the theoretical knowledge that they have learned in class into the laboratory work (Kamilah, 2012). Its help the students to have better understanding on the basic concept of certain engineering equipment function and this can successfully be developed after a series of experiments have been conducted which require the students to operate and analyze the derivable data.

At present, many studies have been done especially in designing suitable instructional approach that can be used in ensuring the effectiveness of laboratory courses conducted for engineering students to improve their learning. Johnstone et *al.* (1994) reported that previous traditional or conventional laboratory only requires little involvement of students' knowledge. Students have been provided by the experiments procedure and can just follow and solve with less knowledge about it. This has led to many arguments on the effectiveness of the conventional laboratory practices in enhancing not only the students'skills, but also their learning.

In this 21st century, the conventional laboratory practices have slightly changed to non-conventional laboratory design that is more focused on developing students' learning, practical skill and students' participation in a team using active learning approach in the form of for example case study, project or problem-based. This paper presents the results of a study conducted on the effect of a non-conventional laboratory course particularly the Problem/Project-based Laboratory course or known as PBLab which is one of the core courses in the curriculum of a Bachelor of Engineering

*NurAyuniShamsulBahri.
E-mail address: ayuniayu87@gmail.com

(Electrical) program offered at Universiti Teknologi Malaysia (UTM) on the students by looking at their perception towards the course after having completed it.

2. Conventionalversus Non-conventional Laboratory

Previously, laboratory courses have mainly been conducted in a conventional way of which it is very much inclined towards teacher-centered approach. With such approach, teachers or educators play the role as a giver while the students passively receive the knowledge without contributing more to it (Huba and Freed, 2000). In the context of a laboratory, according to Kelly, O.C. and Finlayson, O.E. (2007), a traditional or teacher-centered laboratory has been conducted by giving the students each step of the procedure of the experiments and they are expected to exactly follow the procedure. This type of laboratory activities is often referred to as a 'recipe lab' (Domin,1999).Sometimes in a'recipe lab', students would be carrying out the same experiments that have been conducted by their seniors and with such scenario; there is a tendency for them to refer to the results that have been obtained by the previous students. This in turn encourages passive contribution of the students in conducting the laboratory experiments. This issue is supported by Johnstone et al. (1994)which highlights that "students can be successful in a laboratory course even with little understanding about what they are doing". In addition although the activities conducted in a traditional laboratory do allow inexperienced students to develop their understanding on how to use the relevant devices and conduct the laboratory work (Garratt, 1997)the transferability skill to apply knowledge and concept that they have learned in designing the experiments is in fact decreased.

In recent years engineering education seems inclined towards promoting the active learning approach which engages students more in the learning process. In short, according to Prince, M. (2004) active learning is a teaching process that naturally forces students to think at what they are doing without directly following the steps. Besides, active learning is often contrasted to the traditional approach where students passively receive information from the educators without being actively engaged in it. There are many active learning approaches that have been widely used nowadays but, the more prominent ones are case-based, project or problem-based learning approach. Several studies have indicated the success of these active Teaching and Learning (T & L) approaches in enhancing students' skill and learning including in laboratory settings.

A study by Wood (1996) has reported that the students were more confident in applying their theoretical knowledge and willing to solve challenging problems after they went through the class lessons that used the Problem-based Learning (PBL) approach. Besides, Caravan (2008) also examined the PBL approach applied in electrical engineering programs in the UK; the results showed that the students preferred the PBLT & L approach because it enables them to develop their thinking and problem-solving skills. Another study by Tom Steiner at el. (2011) found that the students were really interested in the Project-based Learning because they felt that their problem-solving skills improved upon completion of the projects. Another active T & L approach called F.U.S.E (Focus. Unpack problem. Systematically plan. Evaluation) has also been reported to improve students' problem-solving skills (R.Paton, 2010). This method was implemented among the mechanic-students from the University of Auckland. The research found that the students' skills showed some improvements after going through the F.U.S.E course. In fact, more new active T & L approaches are being developed globally.

3. Problem/Project-based Laboratory (PBLab) Course

The "Problem/Project-based Laboratory" or better known as the PBLabis a 4th Year Laboratory course that begins with a "problem or project" as an approach in developing students' thinking and skills in a laboratory setting (N. A. Azli,2010). It has successfully been implemented since 2007 as part of a Bachelor of Engineering (Electrical) program curriculum that has resulted in active participation of the students compared to the previous conventional laboratory format. The aim of the PBLab is to induce some changes in the laboratory conduct from a teacher-centered approach to a student-centered approach by introducing real-world or close to real-world problems or projects to be solved in a group. This is in line with the emphasis in engineering education for graduates with capabilities beyond the following of procedures but instead creating them and analyzing the data in order to solve a given problem.

Students in the PBLab are given problems or projects to solve within a given period. Besides, in the PBLab, the role of the lecturers have changed to becoming facilitators whose main responsibility is to facilitate the students in moving forward towards solving the given problems or projects rather than telling students directly what to do and what they should learn. Unlike the previous conventional laboratory conducted, PBLab requires the students to develop their own experimental procedure prior to conducting it as part of the problem or project solution. This requires the ability of the students not only to relate their prior learnt knowledge to the given problem or project but also to be engaged in discovery or exploratory learning.

Based on its proposed implementation model, the PBLab has been highlighted as a laboratory course that can encourage students to be good team players and creative problem solvers in the workplace environment (N.A.Azli, 2005). This is due to its structure that exposes students to activities that involve problem solving and active learning in a team. The PBLab for the Bachelor of Engineering (Electrical) program involves three laboratories mainly the Advanced Power, Power Electronics and High Voltage. The students are required to complete a given problem or project as offered by each of the laboratory in 4 weeks throughout the semester. Furthermore, the time allocated for the PBLab is basically 3 hours per week inside the laboratory involving the facilitators and at least 24 hours per week outside of the laboratory involving just the students in their respective groups. The students are divided into a group of 3 to 4.

The activities that are typically carried out in a PBLab from week 1 until week 4 are as given in Table 1. The problems or projects are designed by experts whom in this case are experienced lecturers. Based on the given problem or project, students are required to brainstorm for ideas, discuss, and express their opinions on the probable solutions. This is considered as a challenging learning process for the students as they have to develop deep understanding on the subject matter to establish the suitable methods that can be applied in order to solve the given problem or project. To accelerate this process, a *Student Pack*is made available for each given problem or project (N.A.Azli, 2005). A *Student Pack* consists of relevant material that is beneficial for the students in solving a problem or designing a project.The students are able to download the *Student Pack* from the respective laboratory's website after they have presented the results of their preliminary discussion to the facilitator in charge.

In addition, there is also the *Facilitator Pack* (N.A.Azli, 2005) that is prepared for each problem or project given to the students. This is necessary because not all problem or project designers will become the facilitators. Thus the *Facilitator Pack* is a tool for the facilitators to refer to that basically describes the probable solution for the given problem or the details of the project. Table 2.8 shows that the process of solving the problems or projects ends after the findings or results are acquired. Table 2.8 also displays the facilitators' responsibility in each weekly PBLab sessions and it does indicate the importance of facilitation in ensuring smooth conduct and good progress of the PBLab.The roles of the facilitators as stated by N.A.Azli (2010) are,

1. To facilitate each group in a laboratory session in solving a problem or conducting a project.
2. To evaluate the students' laboratory performance based on the outlined evaluation criteria.
3. To ensure that the evaluation process is completed according to schedule for each assigned problem or project.

In order to ensure that the Bachelor of Engineering (Electrical) program outcomes represented by the PBLab course outcomes are achieved, it is important for the facilitators to assess the students properly based on their achievements in the respective laboratory. For the PBLab, the decision on the assessments methods used has been made by the PBLab Task Force members (N.A.Azli, 2010). In evaluating the performance of the students on the aspect of course outcomes achievement, several assessment methods have been chosen for implementation in the PBLab. Table 2 shows a sample of the assessment methods. Since 2007, the percentage contributing to each method has been reviewed from time to time as part of the course continual quality improvement effort. Furthermore for each assessment method, the evaluation criteria have also been changed for similar reasons. For example in assessing each student's activities in the PBLab, the latest criteria have included a one to one interview between the student and the facilitator in charge.

Table 1. The PBLab activities from Week 1 until Week 4 (N. A. Azli, 2010)

Weeks	In-Lab session (3 hours)	Out-Lab session (2 hours)
WEEK 1 **(**Each group is assigned a problem*)	1. Understanding the problem with guide of facilitator. 2. Brainstorming, giving ideas to solve problem. 3. Identify available resources and tools. 4. Identifying what you know and what you need to know in solving the problem. 5. Facilitator marks individual in-lab activities.	1. Get more resources to help understand the problem. 2. Divide work among group member. 3. Report findings to group. 4. Agree on a solution.
WEEK 2	1. Present solution to facilitator. 2. Facilitator comments on solution, making sure the group is on the right track. 3. Group begins to design the experiment. 4. Group confirms the experiment layout. 5. Facilitator monitor and marks individual in-lab activities and log book.	1. Group conducts some simulation work to reconfirm design. 2. Group verifies the availability of equipment and tools to conduct experiments. 3. Group prepares schematic or connection diagrams for experiment.
WEEK 3	1. Group begins to conduct experiment. 2. Facilitator monitors and marks individual-in lab activities and group log book. 3. Group get results from experimental work.	1. Group prepares slides for presentation of completed work. 2. Group starts preparing report.
WEEK 4	1. Group presentation and demo. 2. Report writing.	1. Continuation of report writing and submission exactly **one week** later to the

	(Facilitator monitors and marks individual-in-lab activities and group log book. Facilitators also evaluate all group presentations).	Lab technician to be recorded and given to facilitators.

*can also be in the form of a project

Table 2: The PBLab Assessments Methods

Assessments	Assessment methods	Percentage (%)
Individual work	Individual in-lab activities (4x)	30
	Peer and Self-evaluation (1x)	10
	Individual presentation (1x)	10
Group work	Group log book (3x)	20
	Group presentation/demo (1x)	10
	Group report (1x)	20
	Total	100

4. Methodology

4.1. Participants

Seven final year undergraduate students from the Faculty of Electrical Engineering, UTM have been selected to participate in this study. All of them are students of the Bachelor of Engineering (Electrical) program which includes four males and three females. In this research, the perception and opinion on the PBLab given by each of these students will be analyzed and presented as its outcomes. Besides, it is important to highlight that the students involved in this research are those who have gone through the PBLab process.

4.2. Procedure

This study is specifically qualitative that uses semi-structured interviews as an approach to collect data among seven selected students. The semi-structured interview process involves a series of open-ended questions based on the research focus area. According to Beverly Hancock (1998), open-ended questions provide opportunities for both interviewer and participants to discuss a topic in detail and give rich data collection. Besides, by using the interview approach, the detail explanation and perception of the students towards the effect of the PBLab on them can successfully be determined.

5. Results and Discussion

To determine the students' experiences and perception regarding the effect of the PBLab on them, semi-structured face-to-face interview sessions have been conducted. The open-ended interview sessions have allowed the students to give more in-depth response regarding the effect of the PBLab which implements problem/project-based as its T & L approach on them. The students have been asked to answer several open-ended questions, but only three questions will be discussed in this paper. The first question that has been highlighted in the interview sessions is the perception of the students regarding the differences between conventional and non-conventional (PBLab) laboratory course that they have gone through. Table 3 gives the examples of some of the responses as expressed by the respondents. Based on the responses obtained, most of the respondents do know the differences between the conventional laboratory and the PBLab. However, there is one key point that has been stressed out many times by the respondents which is

The conventional laboratory has provided them with step-by-step procedures in conducting an experiment compared to the non-conventional PBLab that allows the students to think and solve the given problem or project based on their knowledge and then proceed to designing their own experimental procedure. In addition, based on Table 3, it can be summarized that the students are more comfortable and learn more when they are being pushed to solve real-world problems or projects in the PBLab. On the other hand, *Respondent E* clearly pointed out that the conventional laboratory also has its advantages. Although the previous conventional laboratory did not provide the opportunity for the students to come out with their own experimental procedure or the experience to solve a given problem in a team, it is still valid in providing the students with the experience to handle electrical engineering equipment based on a given procedure. As reported by Kelly, O.C. and Finlayson, O.E. (2007), in conventional laboratories, students get direct opportunities to develop manipulative and technical skills. However, due to the T & L approach of the PBLab, it offers the advantage of allowing the students to express and think about their own thinking in the spirit of team working.

Table 3: Students' perception towards the differences between conventional laboratory and PBLab

Respondent A:
"PBLab is like..we have to find the information by our self and we have to apply what we have learned before…compared to the previous traditional lab, they give us the procedure and we just followed it, try to get the output from it and don't know what we are doing actually. But in PBLab course, we understand better because we started from the beginning of the problem..From week 1 until week 4, we analyze the result, write the report and finally, we understand what we are doing."

Respondent C:
"Conventional lab are more on…All the procedures has been provided and we just have to follow it. But for PBLab, we have to solve the given problem by our self from A until Z."

Respondent E:
"Ermm...for conventional lab, it's more on to teach us how to use the devices. For example, in the class, we just learned the theoretical facts about the devices but when we are in the lab, we learned and know how to use it manually and not only based on theory…But, in PBLab, it's focusing more on how to solve the problem. It teaches us how to start to solve the real-world problem and how to strategize and solve it in a time frame. Besides, in PBLab, we can understand what we are doing better."

In order to focus more on the impact of the PBLab on the students, Table 4 shows the feedback received from the respondents regarding their own perception towards the effect of the PBLab on them after having gone through it. Referring to the table, all respondents answered that the PBLab has given them positive impact. This is mainly due to its T & L approach that gives the students the chance to use their own creativity in devising the strategies to solve a given problem or project while enhancing their problem-solving skills. The comments given have also indicated that the students like to explore and yearns to be given the space to develop and use their own thinking to solve a problem or project without directly following procedures. Besides, PBLab also has given them the experience of working with other students and learn to tolerate with each other despite having any differences in order to complete a given problem or project which would be assessed on group basis. Furthermore, according to Harlen (2006), this active learning approach also can enhance learning when students interact with each other, which recognises the impact of other students' ideas in solving a given problem or project.

Table 4. Students' perception towards the effect of PBLab on them

Respondent A:
"It gives us positive effect because what we have learned from first year until fourth year class can be applied in the PBLab."

Respondent E:
"It's really good because we have to know how to manage. Previously, we are been given the procedure and we just follow and setup the experiments based on the given steps. But for PBLab, we try to setup and solve the given project or problem ourselves. Besides, the problems/projects are real ones"

Respondent F:
"It gives effects...For example, PBLab teaches us how to work with people who have different attitudes and way of thinking."

Besides enhancing the students' learning and their thinking process, the PBLab has also been designed to develop other important generic skills which are equally important for graduating engineers. Table 5 describes the students' feedback regarding the effect of the PBLab on them in developing their generic skills.A few respondents said that the PBLab somewhat has forced them to use the English language as the form of communication because a few of their group members are non-native Malay speakers. Besides that, other skills that have been emphasised by the respondents are report writing and presentation. Respondent C clearly stated that the PBLab has taught him to prepare the project presentation slides within a time constraint. Although there have been other courses which require the students to present their work, with the PBLab all members of a group must be aware of the process involved in solving a problem or completing a project right from the very beginning. If this awareness effort is not embraced by any of the group members, it can easily be detected during the presentation session itself since each of them has to present their part of the presentation material. In addition proper planning and coordination is required as in a very limited time, the students have to present their data in a systematic way so that the audience can clearly understand the presentation. Another skill that has been developed by the students in the PBLab is report writing based on the fact that they are required to complete three reports throughout the semester. This is verified by Respondent E and most importantly the respondent has acknowledged the importance of report writing skill for graduating engineers.

Table 5. Students' feedback on the effect of the PBLab in developing their generic skills

Respondent B: "Yeah..it forces us to speak in English because there are some foreign students in our groups" **Respondent D:** "It has improved my English.." **Respondent C:** "Basically we know how to prepare slides, but during PBLab, it teaches us how to prepare and manage it in a short time..Usually, we will take some time to prepare and design the slides, but in PBLab, it's vice versa." **Respondent E:** "Yes...There is..in PBLab, we have to write a report. Most people said that engineers don't need to be a good report writer, which is wrong. The truth is in order to become a good engineer, you have to be good in writing reports too."

6. Conclusion

This paper has highlighted the responds given by the students regarding the effect of the PBLab on them based on the three forwarded questions. The comments and responds given clearly indicate that the PBLab although rather challenging is well accepted and has brought positive effects not only on the students' learning but also on developing various skills that are important for graduating engineers. There are several other factors that may contribute to the effect of the PBLab on the students particularly on their learning which include the facilitators' attitudes, types of assessments and types of problem or project given. Further investigation and analysis need to be done in future to identify how far these factors effects the students.

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References

ABET. (2012). Criteria for Accrediting Engineering Programs, *Accreditation Commission, Accreditation Board for Engineering and Technology*. Retrieved from: http://www.abet.org/criteria.html

N. A. Azli , C. W. Tan and N. Ramli.(2010). Implementation Model of a Problem-BasedLaboratory (PBlab) Established for a Bachelor Of Engineering (Electrical) Program atUniversiti Teknologi Malaysia, *Regional Conferences Engineering Engineering, Sarawak.*

N. A. Azli. (2005). Proposed Implementation of a Problem Based 4th Year Electrical Engineering Undergraduate Laboratory, *RegionalConference on Engineering Education* (RCEE 2005)

Salim, K.R. (2012). A Model for Assessing Student's Achievement in Basic Electronic Laboratory. Doctoral thesis.

Johnstone A.H., Watt A. and ZamanT.U., (1998), The students' attitude and cognition change to a physics laboratory, *Physics Education*, 33, 22-29.

Huba,M., and Freed, J. (2000). *Learner-cantered assessment on college campuses*. Boston: Allyn and Bacon.

Kelly, O.C. and Finlayson, O.E. (2007),Providing Solution through Problem-based Learning For The Undergraduate 1stYear Chemistry Laboratory, *Chemistry Education Research and Practice,* 2007, **8** (3), 347-361.

Domin D.S., (1999), A review of laboratory instruction styles, *Journal of Chemical Education*, 76, 543-547.

Garratt J., (1997), Virtual investigations: ways to accelerate experience, *University Chemistry Education*, 1, 19-27.

Prince, M.(2004). Does Active Learning Work?A Review of the Research. *Journal of Engineering Education. 93(3),223-231.*

Woods,D. R. (1996).Problem-based learning for large classes in chemical engineering. In L. Wilkerson & H. Gijselaers (Eds.), *Bringing problem-based learning to higher education.* San Francisco, CA: Jossey-Bass.91–99.

Caravan, B. (2008). A summary of the findings from an evaluation of problem-based learning carried out at three UK universities. *International Journal of Electrical Engineering Education,45*(2):175–180.

Beverley Hancock.(1998). An Introduction to Qualitative Research, *Trent Focus for Research and Development in Primary Health Care*.1-26.

R. Paton. (2010). Making problem-solving in engineering-mechanics visible to first-year engineering students, *Institution of Engineers Australia,, Australasian Journal of Engineering Education*.16 (2).

Harlen W., (2006), *Teaching, learning and assessing science 5-12,* SAGE Publications, London

The Effectiveness of Problem-based Learning Approach on Students' Skills in Technical Vocational Education and Training (TVET) Specifically on Programming Course Using a Computerized Numerical Control (CNC) Simulator.

Hashim Mohamad [a] *, E. de Graaff [b]

[a]German-Malaysian Institute, Taman Universiti, 43000 Kajang, Selangor Malaysia
[b]UNESCO Chair in PBL in Engineering Education, Aalborg Universitet
9000 Aalborg, Denmark

Abstract

Industry has a great need for highly skilled technicians that graduate from Technical Vocational Education and Training (TVET). In a study started at Aalborg University (AAU) the purpose is to evaluate the effectiveness of the (PBL) approach on students' skills, in particular on programming course using a Computerized Numerical Control (CNC) simulator. The study will use data from the German-Malaysian Institute in Malaysia. The findings of this study will provide a general guideline for educators in Technical and Vocational Education and Training (TVET) institutions in implementing Problem-Based Learning (PBL) at Diploma level of the students. In this paper we will present the research method which will be used to address the research questions. The research methodology used in this study is mixed methods with combination of qualitative and quantitative approaches during different phases of research process.

Keywords: Evaluate; Effectiveness; Technical Vocational Education and Training; Problem-based Learning;

1. Introduction

1.1. Research Background

The German-Malaysian Institute established in 1991 has more than 21 years in operation as a technical and vocational training institute. The institute aims to support the Malaysian industries by producing highly skilled and competent technicians/technologist that are able to operate modern technologies efficiently. This is in line with the government's Third Industrial Master Plan (IMP3) which emphasizes improvement of the number and quality of skilled workers who could respond to the changing environment and enhancing competitiveness.

Recently, the German-Malaysian Institute (GMI) had changed the training approach for some courses from a teacher-centred to a student-centred approach by implementing PBL. Typically, technical and vocational subjects are delivered using the traditional four step method training approach: describe, demonstrate, try-out by trainee and evaluate with feedback. In technical and vocational training, students need to acquire technical skills through hands-on-work that enables them to solve authentic problems from industry. However, students trained with this traditional approach lack some generic skills such as problem solving, critical thinking, communication and leadership. In order to transform the traditional training approach to PBL, GMI had adapted the model (figure 1) introduced by Neo T K & Neo M, (2005).

With PBL, Technical Training Officers (TTO) and students are required to change roles. TTO acts to facilitate the learning rather than to provide knowledge. The students have to engage in an active learning process help them develop flexible knowledge, problem-solving skills, self-directed learning skills, collaboration skills and intrinsic motivation (Hmelo-Silver, 2009). The PBL approach requires the students to be self-directed or self-regulated with respect to their own learning process.

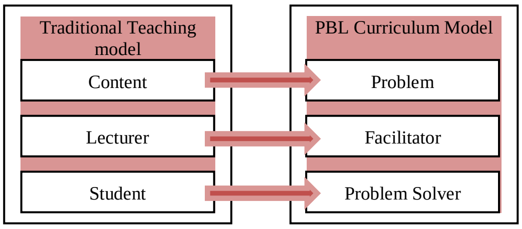

Figure 1. Curriculum Transformation Model

* Corresponding Author: Hashim Mohamad
E-mail address: hashim@gmi.edu.my

In order to materialize the change of the teaching approach from traditional methods to PBL in the German-Malaysian Institute (GMI), a group of 25 Technical Training Officers were exposed to PBL trainings and workshops in Republic Polytechnic, Singapore in 2008. Furthermore, a number of Technical Training Officers were also sent to universities overseas to further their study in PBL. For the same reason, a PhD study is initiated aiming to evaluate the effectiveness of PBL approach to TVET. The study was positioned at the UNESCO centre for PBL at Aalborg University in Denmark, a well-known centre of expertise on PBL.

This study will have the data collected at the German-Malaysian Institute with students at Diploma level of Technical Vocational Education and training (TVET). The purpose of this study is to evaluate the effectiveness of PBL approach on GMI's students' skills on programming course using a Computerized Numerical Control (CNC) simulator. The study will be conducted with groups of GMI's students at Diploma level and teaching staffs (facilitators) for a period of 6 months. The big question is how to demonstrate the effectiveness of the alternative approaches (PBL) as far as the students' skills in Technical Vocational Education and Training (TVET) is concerned. In this paper we will present the research design aiming to address the research questions. The study will use mixed methods, a combination of qualitative and quantitative approaches during different phases of research process. The findings of this study will provide a general guideline for educators in Technical and Vocational Education and Training (TVET) institutions in implementing Problem-Based Learning (PBL) specifically on part programming using CNC simulator by Diploma level of the students. The potential benefit of this study is the answer to research questions how effective the PBL approach to TVET.

1.2. Research Overview

This study is a PhD project situated at Aalborg University (AAU), Denmark. This study will have the data collected at the German-Malaysian Institute with students at Diploma level of Technical Vocational Education and training (TVET). The purpose of this study is to evaluate the effectiveness of PBL approach on GMI's students' skills on programming course using a Computerized Numerical Control (CNC) simulator. The study will be conducted with groups of GMI's students at Diploma level and teaching staffs (facilitators) for a period of 6 months. The big question is how to demonstrate the effectiveness of the PBL approaches as far as the students' skills in Technical Vocational Education and Training (TVET) is concerned. In this paper we will present the research design aiming to address the research questions. The study will use mixed methods, a combination of qualitative and quantitative approaches during different phases of research process. The findings of this study will provide a general guideline for educators in Technical and Vocational Education and Training (TVET) institutions in implementing Problem-Based Learning (PBL) specifically on part programming using CNC simulator by Diploma level of the students.

1.3. Problem-Based Learning

The significance for GMI to Implement the Problem-Based Learning in its Technical Vocational Education and Training is to enhance students' learning skills which include the methodological skills and energy to continue learning independently after training at GMI. According to a study by Bridges (1992), PBL approach triggers the students' learning and they become highly motivated, they enjoy the activities they do, appreciate the value of what they learn, consider about how they will use their newly acquired knowledge and skills in the real situation in future and experience sense of achievement upon completion of a project. The students cannot continuously be spoon-feeding in acquiring knowledge but they should be exposed to "learn how to learn" to help them cope with demands of a rapidly changing and competitive working environment. The technical training provider should develop learning opportunities that help students develop problem solving skills and lifelong learning. Bridges (1992) underlined four major goals of PBL: (1) acquisition of the knowledge base underlying administrative practice, (2) development of administrative skills, (3) development of problem-solving skills, and development of lifelong learning skills. The employers in the industries wanted students who could think critically, solve problems and work in teams with other employees. Furthermore, students in the problem-based learning environment have developed stronger clinical competencies although the differences were small and non-significant (de Vries, Schmidt, & de Graaff, 1989). Problem-Based Learning is an educational strategy and a method to organize the learning process in such a manner that the students are actively engaged in finding answers by themselves (Graaff and Kolmos, 2007). Learners in this environment play an active role in the knowledge acquisition process by attempting to solve ill-structured problems through participation in small group discussions and self-study (Albanese, 1993). The learning is triggered by offering ill-structured problems, providing a more realistic approach to learning and creating an educational method which emphasizes real world challenges, higher order thinking skills, multi-disciplinary learning, independent learning, teamwork and communication skills (Schmidt, 2005). Self-Regulated learning is ubiquitous in research on education nowadays and it is an umbrella term for various processes such as goal setting, metacognition, and self-assessment, all of which influence learning in various ways (e.g., Boekaerts 1999; Paris and Paris 2001; Zimmerman 1989). The criteria for effective teaching and learning are all fostered in small group interactions especially in PBL. Small group teaching depends more on the characteristics displayed by that group rather than the numbers in it. Therefore, the aim of a small group session should be to encourage students to adopt deep approach towards learning and to be a self-directed active learner (Walton, 1999). PBL is an approach in learning and instruction in which students tackle problems in small group under the supervision of a tutor (Schmidt, 1983). The principal idea behind PBL is that the starting point of learning should be a problem, a query that the learner wishes to solve (Boud, 1985). Students work on the problem to identify and search for the knowledge that they need to obtain in order to approach the problem (Davis & Harden, 2005). To assist students to be effective in their learning, teachers should help students become aware of alternative ways of approaching learning situation (McKeachie, 1988), but Weinstein and Mayer (1986) suggest that learning strategies appropriate for one type of learning situation may not be appropriate for another. It is important to prepare students for self-directed learning and the PBL process by conducting and orientation at the beginning of the course or program (Ong, 2006). "PBL is a different concept that not many people have heard of. It is important for the school to communicate the purpose to all staff and students; otherwise, both teachers and students will be left in the dark, only to group for the rationale" (Yeo, 2005). Weizman (2008) had underlined several components in order to be successful in applying PBL approach. The components include:

- Strong conceptual understanding of subject matter.
- The ability to apply knowledge in new or unanticipated contexts for problem solving.
- The ability to reason with incomplete information and make decisions that will be the best for the class as well as for individual students.
- Motivation for self-directed learning to stay apprised of current thinking within their subject matter.

1.4. PBL's Effectiveness

Many studies had been made on the effectiveness of PBL implemented in medical education, engineering, higher education and etc. These findings had shown the positive effect on the students' behaviour toward learning. Learning styles is broadly described as the cognitive, affective, and physiological behaviours that are relatively stable indicators of how learners perceive, interact with, and respond to the learning environment (Keefe, 1979). Studies had also shown that the students who acquired knowledge by solving problems (PBL) more likely to use it spontaneously to solve new problems (Bransford, Franks, Vye, & Sherwood, 1989). PBL approach is proven to be very effective in educating and propagating learning among students. However, the successful of PBL implementation apparently depend on many factors that will influence the effectiveness of PBL approach. In the context of this study, the factors that might influence the effectiveness of PBL implementation are the PBL curriculum design, material development such as the quality of problem crafting, student PBL orientation and teacher's facilitation skills. However, in this study, the researcher measures the effectiveness of PBL is based on the learning outcomes from the programming course using a Computerized Numerical Control (CNC) simulator which is the knowledge, hand-on skills and key qualifications such as presentation skills, communication skills and etc. The findings from the research questions will also be taken into consideration to evaluate the effectiveness of PBL in this study.

2. Research Methodogy

The expected outcome of the study is a general guideline for educators in Technical and Vocational Education and Training (TVET) institutions in implementing Problem-Based Learning (PBL) specifically on programming course using a CNC simulator by Diploma level of the students. Hopefully, the guideline will be also applicable for educators to implement PBL for students in any TVET discipline at certificate level. In order to achieve this outcome, several comprehensive studies on current practise PBL approach in TVET will be conducted.

At this stage we employ the mixed methods design comprising qualitative and quantitative methods approaches in order to obtain data from the current practise of the PBL group's participants (Students and Teaching Staffs). This research will use the concurrent mixed methods approach in which the researcher converges or merges qualitative and quantitative data in order to provide a comprehensive analysis of the research questions (Creswell, 2007). Both forms of data will be collected at the same time and then integrates the information in the interpretation of the overall results (Creswell, 2007). In the qualitative methods of data collection, the teaching staff will be asked to gather data on verbal and non-verbal during the class session, students' interactions, students' reflection, students' learning skills & attitudes and problem-solving skills. The interviews will be used to explore students' perceptions about Problem, Project and Production-Based Learning as well as those of the teaching staff and educational management. The questionnaire will be the instrument to survey each student's perception about PBL approach. Learning experiences recorded by the questionnaire will be used to validate the data collected from the interviews. The content analysis will be used to analyse students' findings and justifications to a problem for their problem solving skills. The combination of qualitative and quantitative data provides a thorough understanding in addressing the research questions below, in particular to provide complementary qualitative data if quantitative data are inadequate (Creswell, 2007). The quantitative methods of data collection will be through: (1) pre-tests, (2) post-tests and (3) practical test. The students will be subjected to these instruments to evaluate on their learning skills and hands-on skills and this will also serve to validate the data that will be collected through a qualitative approach. Throughout the research, the researcher may embed one smaller form of data within another larger data collection in order to analyse different types of questions in which the qualitative addresses the process while the quantitative, the outcomes (Creswell, 2007).

2.1. Research Questions:

At the start of the research project the following research questions were formulated:

1. How do GMI/AAU students perceive the concepts Problem, Project and Production-Based Learning approach for TVET?

2. To what extends do the learning facilities and infrastructures in GMI influence the effectiveness of the PBL implementation in TVET?
3. What typical activities take place in the PBL learning environment?
4. To what extend does the PBL approach promote students' (GMI) learning skills in TVET specifically on programming course using CNC simulator?
5. What kind of learning experiences contributes to the professional development of highly skilled technicians?
6. To what extends do the students' (GMI) academic backgrounds influence the effectiveness of the PBL implementation in TVET?
7. To what extents do the students' (GMI) learning attitudes influences the effectiveness of the PBL implementation in TVET?
8. To what extents do the students' (GMI) problem-solving skills influences the effectiveness of the PBL learning in TVET?
9. To what extends do the GMI students' benefits from the CNC simulator in the PBL approach?

In order to achieve the desired outcome, this study needs to do research on a variety of PBL approaches such as Product, Project, or Production Based Learning. Eventually, this will allow researcher to come to a conclusion which PBL approach is most appropriate to be used in TVET. The main concern in TVET is to develop hands-on skills and the main concern in PBL is the development of skills such as critical thinking, problem solving, learning and etc. This study is also aiming to find a compromise between both the traditional and the PBL approach in developing hands-on skills in TVET. In other words, it is a combination of both.

3. Discussion and conclusions

3.1. Discussion

The expected outcome of the study is to develop a general guideline for educators in Technical and Vocational Education and Training (TVET) institutions in implementing Problem-Based Learning (PBL) specifically on programming course using a CNC simulator. In order to achieve the desired outcome, this study needs to do research on a variety of PBL approaches such as Product, Project, or Production Based Learning. Eventually, this will allow us to come to a conclusion which PBL approach is most appropriate to be used in TVET. The main concern in TVET is to develop hands-on skills and the main concern in PBL is the development of skills such as critical thinking, problem solving, learning and etc. This study is aiming to find a compromise between both the traditional and the PBL approach in developing hands-on skills in TVET. In other words, it is a combination of both.

The primary data collection will be done in the German-Malaysian Institute in Malaysia. Still, the possibility to compare some aspects of the PBL implementation in Aalborg University in Denmark with GMI in Malaysia is under consideration. Presently nine research questions are formulated as focus of this study. However these research questions will have to be narrowed down as the research progresses. Hence, there will be a process of reformulation on the research questions and elaboration of the research design. The data collection of this study will emphasize the PBL approach rather than the traditional approach, because GMI already has the statistic of students' results trained in traditional approach. This study (research question 6) also concerned with the low achievers (GMI's students) in academic background as this will indirectly influence the effectiveness of PBL in TVET.

With respect to this study some limitations have been identified that are supposed to affect the findings of this study. These limitations are the followings:

1. The sample of this study will be teaching staffs and students from GMI comprising 6 groups of 4 per group as the grouping of students per class is 24 students.
2. Restricted to the technical and vocational education training which emphasize hands-on skills for students at Diploma level specifically on programming course using CNC simulator.
3. Difference in the level of prior knowledge of each student.
4. The level of education background of each student may be different because they come from various schools, technical schools, technical institution and technical college.

3.2. Conclusion

The potential benefit of this study is the answer to research questions how effective the PBL approach to TVET. Even if this study perhaps might not answer all research questions, it will trigger more studies on the PBL effectiveness in TVET in the future. TVET education is highly essential especially in the Malaysian context as Malaysia is moving towards an industrialized country and the responsible of the TVET institutions to produce highly skilled and competent technicians/technologist to support Malaysian industries. Presently, the development of human capital with multiple competencies is in great demand and personnel with only one technical competency is no longer competitive and will not survive in the globalization era (Ngan C. H., 2010). GMI had taken an important step forward to change the TVET training approach from traditional to PBL approach. This study will hopefully benefit not only to GMI but also to all TVET institutions in Malaysia. The significance of this study is to provide tool to the technical and vocational training providers particularly in Malaysia or countries with similar conditions, as the general guideline that will be produced will help them to develop and implement PBL at their training institution. Hopefully, this study could contribute to better and effective of PBL implementation in TVET and increase the learning skills of students as well as their hands-on skills to prepare them for a challenging working environment.

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References

Albanese, M.A. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic medicine: Journal of the Association of American Medical Colleges*, *68* (1), 52-81.

Boekaerts, M. (1999). Self-regulated learning: where we are today. International Journal of Educational Research, 31, 445–457.

Boud D. (1985), *Problem based Learning in perspective in education for the professionals,* Sydney, Higher education research and development of Australia.

Bransford, J. D., Franks, J. J., Vye, N. J., & Sherwood, R. D. (1989). New Approaches to Instruction: Because Wisdom Can't Be Told. In S. Vosiadou & A. Ortony (Eds.), *Similarity and Analogical Reasoning* (pp. 470-297). New York: Cambridge University Press.

Bridges, E. M., & Hallinger, P. (1992). Problem-Based Learning For Administrators. Eugene, OR: ERIC Clearinghouse on Educational Management, University of Oregon.

Creswell, J., Clark, V. (2007), Designing and Conducting Mixed Methods Research, Sage Publication Inc., Thousand Oak, pp. 31-35.

Davis, M. H. & Harden, R., (2005). *Problem Based Learning: A practical guide,* AMEE Medical Education guides no 15, University of Dundee, Scotland, U.K.

deVries, M., Schmidt H. & deGraaf E (1989), Dutch Comparisons: Cognitive and Motivational Effect of Problem-Based Learning on Medical Students, *New directions for Medical Education,* pp. 231-38.

Graaff, E. d. & Kolmos, A. (Eds.) (2007). Management of change: *Implementation of Problem-Based and Project-Based Learning in Engineering.* Rotterdam: Sense Publishers.

Hmelo-Silver (2009), What do We Know about Problem Based learning? Current Status and Future Prospects, 2nd International Problem based Learning Symposium, pp. 2-19.

Jones, E. A. (1997). *Identifying college graduates' essential skills in reading and problem solving: Perspectives of faculty, employers, and policy makers*. University Park, PA: National Center on Postsecondary Teaching, Learning, and Assessment.

Keefe, J. W. (1979). Learning style: An overview. *Student learning styles.* Reston, VA: National Association of Secondary School Principals.

McKeachie, W. J. (1988). The need for study strategy training. In C. E. Weinstein, E. T. Goetz, & P. A. Alexander (Eds.), *Learning and study strategies:Issues in assessment, instruction, and evaluation* (pp. 3-9). San Diego, CA: Academic Press.

Neo T. K. & Neo M. (2005), Engaging Students in Problem Based Learning (PBL) in a Malaysian Classroom - A Constructivist Approach, PBL Conference.

Ngan C. H. (2010), GMI Problem, Project and Production Based Learning (Pro3BL). GMI (Kajang): Brochure.

Ong Tan Hoon, J. (2006), Getting Started in Problem-Based Learning, *Excellence in Education and Training Convention.*

Paris, S. G., & Paris, A. H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36, 89–101.

Roland Yeo, (2005) "Problem-based learning: lessons for administrators, educators and learners", International Journal of Educational Management, Vol. 19 Iss: 7, pp.541 - 551

Savin-Baden, M. (2000). Problem-based Learning in Higher Education: Untold Stories. The Society for Research into Higher Education and Open University Press, Buckingham.

Schmidt, H. G. (1983). Problem-based learning: Rationale and description. Medical Education, 17, 11–16.

Walton H., (1999). *Small group methods in Medical teaching.* Medical Education booklet -1, Reproduced with the permission of ASME,12 Queen St, Edinburgh, EH2 1JE.

Weinstein, C. E., & Mayer, R. E. (1986). The teaching of learning strategies. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd Ed., pp. 315-327). New York: Macmillan.

Weizman, A., Covitt, B., Koehler, M. Lundeberg, M., Oslund, J., Low, M., Eberhardt, J. & Urban-Lurain, M. (Fall 2008). Measuring Teachers' Learning from a Problem-Based Learning Approach to Professional Development in Science Education. *The Interdisciplinary Journal of Problem-based Learning, Vol. 2(2), pp. 30 – 60*

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. Journal of Educational Psychology, 81, 329–339.

Using architecture pedagogy to enhance engineering education

Shannon M. Chance [a] *, Mike Murphy [b], Gavin Duffy [b], Brian Bowe [b]

[a]*Hampton University, Department of Architecture, Hampton, Virginia 23668, USA*
[b]*Dublin Institute of Technology, Bolton Street, Dublin 1, Ireland*

Abstract

Based on evidence, numerous advisory boards and scholars insist engineering education must change (NSB, 2007; McKenna, Froyd, King, Litzinger, & Seymour, 2011) and that hands-on, inquiry-driven, project-based learning pedagogies can enhance STEM education (Boyer & Mitgang, 1996). These pedagogies have formed the core of architectural education since the Renaissance and have been in continuous use since that time. As such, engineering educators can benefit from observing how architecture students learn and understanding how they are taught. Likewise, architecture can benefit from applying the group-based learning strategies employed by engineering teachers who use student-centered, project-based pedagogies. Trans-disciplinary approaches hold particular merit.

Keywords: Project-based learning, experiential learning, studio, cognitive development, intellectual development, architecture

1. Introduction

In its mandate to enhance science and engineering education, the National Science Board (henceforth NSB, 2007) asserted, "*Engineering education must change in light of changing workforce and demographic needs"* (p. 1). The NSB has been quite specific in how it expects these changes to occur. To improve engineering education, the NSB advocates hands-on activities, collaborative work, and real-life applications that have social relevance. Additionally, the NSB recommends that educators integrate systems content as well as "component-level content" (p. 4) in the courses they teach. These are essential aspects of problem-based learning and of its more extensive cousin, project-based learning. Both of these are referred to as PBL, but the later better reflects the type of experiential learning defined by Kolb (1984). They have been used to teach architecture for centuries (see Figure 1).

Figure 1. At Hampton University, students in the second year architecture studio work in groups to create designs that reflect site, program, and construction consideration and synthesize them into the design of complex objects.
Figure 2. Engineering labs at the Escola Superior de Tecnologia e Gestão de Águeda (Universidade de Aveiro) are set up for group learning. Past projects, created by teams of students, line the walls of many labs.

Engineers "need to be adaptive leaders, grounded in a broad understanding of the practice and concepts of engineering" (NSB, 2007, p. 2). The NSB identified this as a current deficit in engineering. The NSB described shortfalls in engineering graduates' ability to navigate "complex interrelationships [that] encompass human and environmental factors." These attributes are also required of architects and there is ample evidence of how they are developed within architectural students. Because the pedagogy employed in architectural education has been successful in instilling these abilities in students, the approach holds considerable significance for educators in engineering (Arens, Hanus, & Saliklis, 2009; Boyer & Mitgang, 1996; Boyer Commission, 1998; Eastman, McCracken, & Newstetter, 2001).

Universities across the United States, and indeed across the world, are attempting to achieve the NSB's goals. In fact, an increasing number of institutions are now using studio-based courses to teach STEM subjects (science, technology, engineering, and mathematics). In similar fashion, others now assign design projects to engineering, biomedical, and interdisciplinary groups

* Corresponding Author Shannon Chance. Tel.: +353-85-788-4677
E-mail address: shannonchance@wm.edu

of students (Boyer Commission, 1998; Eastman, McCracken, & Newstetter, 2001). Some engineering programs are beginning to structure their curricula around projects. Engineering programs at the Escola Superior de Tecnologia e Gestão de Águeda (Universidade de Aveiro) are much like architecture in the US, with content-based course supporting high-credit design-based activities (see Figure 2).

Such programs put student assignments in context so that they are less abstract. This helps students become more flexible engineers who are able to see relationships in the broader context, think iteratively, direct their own learning, adapt to the changing context and requirements of professional practice (Arens, Hanus, & Saliklis, 2002; Boyer & Mitgang, 1996). The NSB noted that such pedagogical techniques also help (1) make engineering more relevant to a broader group of students and (2) attract and retain a more diverse group of students—two critical outcomes the NSB seeks to achieve. In response to such needs, PBL formats are being implemented in more and more engineering classrooms. However, there is much room for research, improvement, and expansion in the use of PBL (McKenna, Froyd, King, Litzinger, & Seymour, 2011).

Figure 3. Engineering and architecture students work side by side to generate new designs, apply emerging technologies, build houses, educate the public about them, and compete in the US Solar Decathlon, held every second year (US Department of Energy, 2009).
Figure 4. At the University of Michigan, students enrolled in the *SmartSurfaces* (an elective design studio) work on trans-disciplinary group-based design problems. Here, students are presenting designs for "biomenetic" SmartSurfaces (SmartSurfaces, 2010).

For instance, this type of cross- or trans-disciplinary learning is evident in the project-based design studios conducted at the University of Michigan under the title *SmartSurfaces* (Marshall**,** Shtein, & Daubmann, 2011) and in Solar Decathlon studios conducted around the country and around the world (see Figure 3). In *SmartSurfaces*, trans-disciplinary teams (of students majoring in architecture, art and design, and materials engineering) work together to design "smart" surfaces that have specific, yet ill-defined, properties. In past years, students have designed biomimetic surfaces (see Figure 4), heliotropic surfaces, and solar-powered surfaces for a "Power House" located in Detroit. The blogs written by students in these courses document and illustrate learning that occurs due to cross-pollination of disciplinary knowledge and skills. Students in all these disciplines need to learn creative, contextual, and critical thinking. Their blogs indicate that are better prepared to work with people from other professions after completing this course.

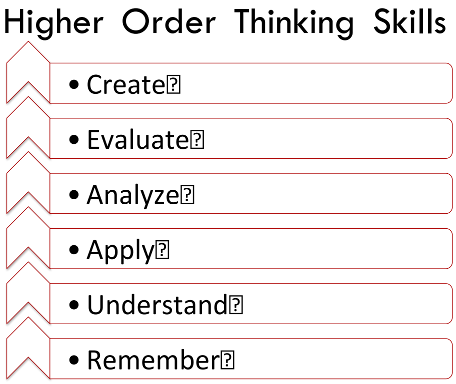
Despite inspiring examples like these, the use of projects in engineering education is typically much more reserved than it is in architecture. This paper argues for more extensive use of context-dependent, ill-structured, project-based pedagogies in engineering. It explains how this is accomplished in architecture and explains potential benefits related to cognitive and intellectual development.

2. Architecture pedagogy

Architecture education is well known for employing studio pedagogy and other active learning techniques to teach students to “think outside the box” and apply knowledge with regard for and sensitivity to context. A three-year study conducted by Ernest Boyer and Lee Mitgang (1996) led these education experts to assert that “architectural education is really about fostering the learning habits needed for the discovery, integration, application, and sharing of knowledge over a lifetime” (p. xvi). Architecture’s studio-based pedagogy involves hands-on, problem-based learning in a workshop setting. Architectural design projects are vehicles that help students develop concepts and apply critical thinking to an increasingly complex range of issues over time. This approach is used worldwide to teach architecture and is sometimes also employed in the training of urban planners, engineers, and scientists as well (Boyer Commission, 1998; Newstetter, Behravesh, Neressian, & Fasse, 2010). In addition, medicine and art use similar techniques.

“The study of architecture is among the most demanding and stressful on campus,” Boyer and Mitgang (1996) asserted, “but properly pursued it continues to offer unparalleled ways to combine creativity, practicality, and idealism” (p. 5). These two scholars are “convinced that architecture education, at its best, is a model that holds valuable insights and lessons for all of higher education.” In fact, they found it to be “one of the best systems of learning and professional development that has been conceived.”

Arens, Hanus, and Saliklis (2009) argued that the studio-based model “is particularly well-suited for the education of engineers because of its attempt to blend both art and science in the ‘learn-by-doing’ experience” (p. 5). Although architecture students learn to make decisions in context, such is often not the case for engineering students. Arens and his colleagues explained that engineering programs tend to emphasize the lowest-order thinking skills on Bloom’s six-level Taxonomy (see Figure 5). In the past, they say, accreditation standards stressed lower-order skills and left the highest skills to students to master in graduate school or in the field. Like assert that typical engineering assignments lack adequate context.



(Bloom’s Taxonomy as revised by Anderson & Krathwhol, 2001)

Figure 5. Bloom's Taxonomy (1956) as revised by Anderson and Krathwhol (2001).

Arens, Hanus, and Saliklis (2009) note that in contrast, architecture education focuses on honing students' higher-order abilities, such as analysis, evaluation, synthesis, and creation. These values are built into architectural accrediting standards (The National Architectural Accrediting Board, 2009) and are upheld in practice (Boyer & Mitgang, 1996). Arens *et al*. urge comparing the way engineers learn in lectures and labs "to a studio environment in an undergraduate Architecture curriculum, where the faculty often begin with the highest levels, such as Evaluation in applying value judgments about the adequacy of the design and Synthesis, by putting disparate pieces of information together, and Analysis in solving large complex problems by reducing them to smaller pieces" (p. 1).

On the other hand, architecture educators are prone to leave the acquisition of specific bits of knowledge (such as specific building codes, zoning regulations, and cost factors) for students to learn during professional internships. As such, they sometimes sacrifice delivery of technical content in favor of helping students master "design thinking" skills. In doing so, they aim to empower students to be capable of self-directed learning.

Oberall, it appears that format known as the *design studio* or *atelier*—used by architects for centuries—might be of value to engineers. The studio format provides a collaborative way of working that fosters creativity and ingenuity. This format emphasizes collective learning over hierarchy. As explained previously by Chance (2008), the word *atelier* is common among western languages, and is often used interchangeably with the English word *studio*. Both terms refer to an artist's workshop, a place where art or architecture is taught, or a location where skilled workers produce art or other finely crafted objects. The design studio is also commonly conceptualized as an experimental design laboratory or workshop. In reality, Chance notes, the studio functions much like a conventional newsroom, where people work in a wide-open space to actively refine a product that involves some sort of communication. The studio format that is commonly employed in design fields promotes quick, creative action. Workers in the design studio endeavor to envision and/or create meaningful products. In many cases, they develop an overarching concept or vision that helps define and unify their creations. Using the studio metaphor might also provide a way to re-conceptualize how engineering is practiced, to more effectively harness the creative potential of individuals and of the collective staff.

3. Engineering pedagogy

In engineering, these pedagogies are often described as Project-Based or Problem-Based and Student-Centered. The unifying theme of PBL and other SCL approaches is that they are inductive, the problem or project is presented first and this drives the learning so that students develop questions before seeking answers. We argue that these methods—particularly the ones that use group-based learning pedagogies—are highly suited to engineering education. When learning in a group-based, project-driven format, students are required to concurrently develop technical and non-technical knowledge and skills. As such, learning, teaching and assessment must be aligned with the delivery of technical *and* nontechnical outcomes. In a study by Moesby (2005), employers rated graduates from a student-centered institute much higher on a range of non-technical skills than their counter parts from a traditional institute.

3.1. Student-Centered Learning

Student-Centered Learning (SCL) pedagogies focuse attention on the learner's needs and abilities. They aim to help students achieve levels of engagement and thinking (Biggs & Tang 2007) higher than required in more traditional formants (where the teacher and the teacher's knowledge take center stage). SCL approaches include problem-based learning (PBL) as well as enquiry learning, project-based learning, discovery learning, case-based teaching and just-in-time teaching. Prince and Felder (2006) conducted a review of these learning and teaching methods and concluded that they: (1) encourage deep learning, (2) improve critical thinking and self-directed learning, and (3) are based on theories of learning and an established understanding of how the brain functions.

3.2. Project-Based Learning

As discussed previous by Duffy and Bowe (2010), the group-based project or problem driven approach typically requires students to work in groups of three to six. Groups explore a problem or project that is aligned with their prior knowledge but that requires them to stretch beyond it. Each group follows an iterative process of brainstorming, self-directed learning, and reporting. In the brainstorming phase of the cycle, each group discusses the problem and suggests possible paths and alternative solutions for investigating it. Group members query each other for current understanding.

Duffy and Bowe (2010) suggest roles for various members of the group. They note that a chairperson can manage the group meetings and a scribe can record any tasks or learning goals that must be addressed. However, the entire group should be able to view the notes being generated (this can be compiled on a large pad, whiteboard, or common sheet of paper) so that there is a central point of focus and agreement. The group should delegate tasks to each member before the meeting finishes. Each member must then follow up on that task during the "self-directed phase." This provides opportunity for each individual to develop information literacy skills and learn to manage and direct his/her own learning. This is the rough equivalent of "homework" in other contexts. In this case, the students write their own "homework assignments." Each student develops his or her own strategy for completing the assignment. When the group reassembles, each member brings new findings and information to share with the group. At this point, each group member should explain in her/his own words what s/he has discovered. This provides opportunity for members to teach and question each other.

The process enhances learning and requires students to build skills in communication, negotiation and conflict resolution—as evident in the *SmartSurfaces* blogs. Having addressed some or all of the issues from the last meeting, the group then starts the cycle again by identifying to do next, delegating new tasks, and so on.

A tutor should be present for most, if not all, meetings—to gently guide the process and observe each student's progress. In addition to conducting formal assessment, the tutor will need to monitor learning and group process. In the realm of learning, the tutor should: ask "directing" questions, check understanding, ascertain if tasks have been completed, and help summarize learning. In the realm of group process, the tutor should: openly question the group's decisions, encourage equal participation, include everyone in discussion, help ensure everything is recorded, help keep the group focused, and (here again) summarize learning that has occurred.

4. Cognitive development theories

Despite the documented need to update the way engineering is taught, McKenna, Froyd, King, Litzinger, and Seymour (2011) suggest far too little change has occurred. Forging ahead to develop understanding of how other fields achieve the types of results NSB desires may help transform engineering education. Helpful resources have emerged related to cognition and the development of design thinking skills. For instance, Eastman, McCracken, and Newstetter (2001) provide a comprehensive investigation of design research and student development in the realm of engineering education. Several chapters of their book, *Design Knowing and Learning: Cognition in Design Education*, describe ways to enhance engineering pedagogy. Many of the examples involve the use of design projects and placing assignments in context. Eastman, *et al*. (2001) and Christiaans (2002) have identified the need for better understanding of *design pedagogy* and *learning strategies* in design fields. Likewise, various articles published in the *Design Studies* journal highlight the need for research on pedagogy and learning strategies in design.

A relatively untapped resource for exploring such topics lies in fields known as "college student development," identity development, and intellectual and cognitive development theory. In 1970, Perry published a schema describing the intellectual development of college students based on their ability to navigate complex issues, view issues from multiple points of view, make decisions in context and commit to a contextualized and contextually "relativistic" way of thinking. Although architectural education helps students achieve high levels of contextual thinking, the literature also suggests that some architecture educators require students to take on challenges that exceed their level of readiness (AIAS, 2003; Boyer & Mitgang, 1996; Koch, Schwennsen, Dutton, & Smith, 2002). Stanford (1962) described the importance of balancing challenge and support in order to foster learning. Further study can lead to enhancements in the way project- and studio-based education is delivered—engineering educators who implement SCL may be of help in this realm. The remainder of this paper explores relevant theories that the authors are currently using to explore the efficacy of engineering and architecture education in order to better understand how students in these majors learn and develop.

Kolb (1984) maintained that hands-on, experiential learning helps students develop a healthy process for making well-balanced decisions (see Figure 6). Engineering educators such as Felder and Silverman (1988) agree. In balanced decision-making, the individual uses many different modes of thinking to identify problems, make choices, synthesize findings, and develop solutions. Not too surprisingly, Kolb found that differences exist in the way students in engineering, architecture, art, and sciences learn and haw they make decisions.

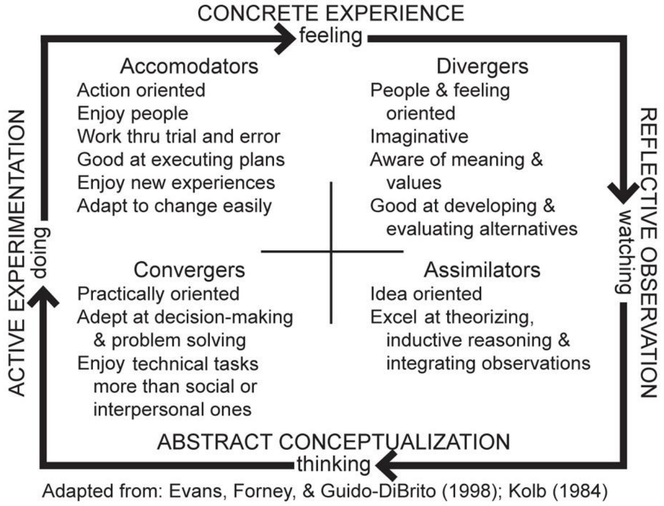


Figure 6. Kolb's (1984) learning styles chart overlapped with his decision-making model.

Table 1 describes typical changes in the way individuals view knowledge, which can be seen as development, over time. It relates these changes to Perry's (1970, 1999) schema of intellectual development. Perry's categories are listed across the top of Table 1, moving from simplistic ways of thinking (on the left) to sophisticated ways of thinking (on the right). The chart defines how an individual's perception typically changes with regard to: what knowledge is, how it is useful, where it comes from, and how it is learned. Most experts on student development believe that few students master the higher levels (*Relativism* and *Commitment*) during their undergraduate years (Love & Guthrie, 1999).

Measuring student performance gains is not new to the field of education. College Student Development scholars offer a number of theories and tools for gauging cognitive development—many of which reflect a high level of agreement. Figure 7 illustrates similarities among cognitive development theories. Various stage theories are shown in horizontal bands. Low-level development is shown to the left, progressing to high-level development on the right. Interestingly, the terms used by various theorists to describe high-level development (*relative, contextual, constructed, cross-categorical* and *trans-system thinking*) mirror architectural terminology.

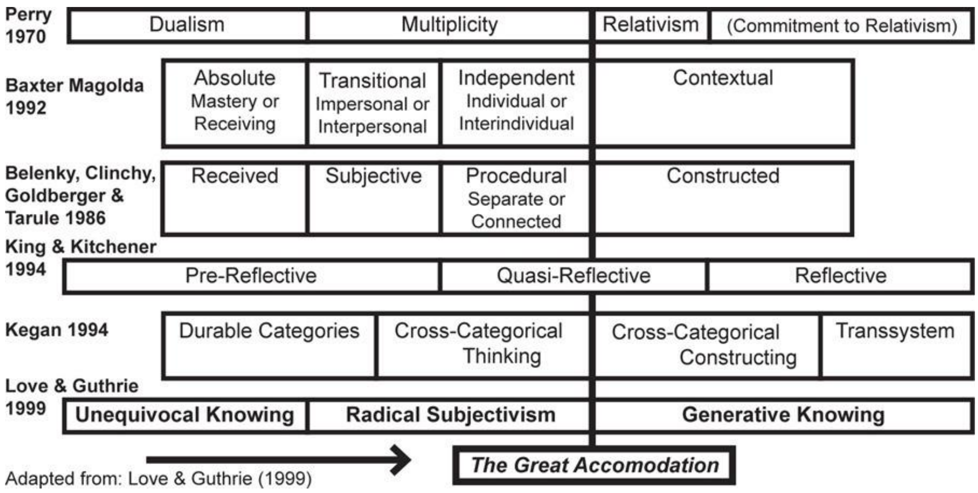


Figure 7. Comparison of student development theories.

Table 1 uses a bold, vertical line to indicate a feature common to most of these theories. This is the break between novice thinking (to the left) and refined thinking (to the right). Perry (1970, 1999) named this transition *revolutionary restructuring*, while Love and Guthrie (1999) describe it as *The Great Accommodation*. Crossing this threshold, the individual is capable of meta-cognition and realizes his or her own power to generate, produce, originate, author, or construct knowledge. The instruments proposed for use in this study were developed to measure development along this axis.

5. Summary

Architectural educators have not yet embraced cognitive development theory to any large extent. However, it appears that many engineering educators are beginning to embrace these theories. As such, architecture teachers have many valuable things to learn from parallel disciplines (student development and engineering education).

On the other hand, architectural educators have been using and refining hands-on, enquiry-driven, and studio-based pedagogies for hundreds of years. Project-based learning is at the core of their practice. In more and more instances, they are using group-based approaches as well. Engineering educators can learn from their knowledge and experience.

Cross- or trans-disciplinary learning is apparent today in design studies that engage engineering and architecture students and professors in teams working on projects. Researching the learning outcomes associated with these studios is essential to build knowledge regarding intellectual and cognitive development, and design process.

Low Level Development	→	Revolutionary Restructuring	→	High Level Development

	Dualism	Multiplicity	Relativism	Commitment
Motivation for Education	instrumental satisfy immediate needs	impress significant others; gain social acceptance; obtain credentials and recognition	achieve competence regarding competitive normative standards; increase capacity to meet social responsibilities	deepen understanding of self, world, & life cycle; develop increasing capacity to manage own destiny
What is Knowledge?	a possession which helps one get desired ends; ritualistic actions which yield solutions	general info required for social roles; objective truth given by authority	know how: personal skills in problem solving; divergent views resolved by rational processes	personally generated insight about self & nature of life; subjective & dialectical; paradox appreciated
What use is Knowledge?	education to get; means to concrete ends; used by self to obtain effects in the world	education to be; social approval appearance, status used by self to achieve according to expectations / standards of significant others	education to do: competence in work and social role; used to achieve internalized standards of excellence and to serve society	education to become; self-knowledge; self-development; used to transform self & the world
Where does Knowledge come from?	from external authority; from asking how to get things	from external authority; from asking what others expect and how to do it	personal integration of info based on rational inquiry; from setting goals, from asking what is needed, how things work and why	personal experience & reflection; personally generated paradigms, insights, and judgments
Learning Processes	imitation; acquire info, competence, as given by authority		discover correct answers through scientific method & logical analyses; multiple views are recognized but congruence & simplicity are sought	seek new experiences; recognize past conception on basis of new experiences; develop new paradigms; create new dialectics
Institutional Function	arouse attention and maintain interest; to show how things should be done	provide predetermined info and training programs; certify skills and knowledge	provide programs which offer concrete skills & info, opportunities for rational analysis & practice, which can be evaluated and certified	ask key questions; pose key dilemmas; confront significant discontinuities & paradoxes; foster personal experience & personally generated insights

Table 1. Typical changes in how students view "knowledge." (Derived from Chickering & Reisser, 1993; MacKeracher, n.d.; Perry, 1999).

A basic premise of our current research is that college students experience varying levels of cognitive development and that it is the role of educators to help move them along this continuum as effectively as possible. Students typically enter college with reliance on a limited set of familiar strategies for learning (Kolb, 1984) and with relatively fixed ideas about knowledge and the role of authority in determining truth and defining knowledge (Perry, 1970, Love & Guthrie, 1999). Factors affecting the student's learning include experiential (e.g., student-centered and/or project-based PBL) and traditional coursework as well as standard age maturation and immersion in university life. Students should leave college with an expanded set of learning strategies and with the skill to think contextually and to generate knowledge. Although it is rare for students to have reached this level of ability after four years of college (Love & Guthrie, 1999), it is the goal of student development scholars and many educators. It is also standard practice in architecture, where students are typically not permitted to continue past second year unless they have demonstrated significant ability in creativity and contextual thinking.

Theories describing how students develop cognitively and epistemologically can be of use to educators who want to promote positive growth and healthy development. In light of these theories, it appears that the architectural studio model has been highly successful, which also supports the continued use of such pedagogies over hundreds of years. It is accomplishing the type of student development that engineering educators and the NSB (2007) would like to see. It makes sense to apply such approaches to engineering disciplines in order to increase the field's overall success. Architectural education provides a valuable precedent that is typically overlooked by engineering educators. The irony is that students continue flocking into architecture schools (even while the economy is such that it can't employ all the architects that universities graduate in roles for which they have been educated). Architectural students appear to value the sense of engagement and creativity they associate with practicing architects. Engineering fields offer similar outlets for creativity, yet they struggle to attract students.

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References

AIAS Studio Task Force (2003). *Paper for Consideration in the Studio Culture Discussion: 2003 NAAB Validation Conference*. Washington DC: The American Institute of Architecture Students. Retrieved Thursday, July 17, 2008, from http://www.aias.org/studioculture/r_resources_sctf_NAABpaper.pdf

Anderson, L. W. (Ed.), Krathwohl, D. R. (Ed.), Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J., & Wittrock, M.C. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* (Complete edition). New York: Longman.

Arens, R. M., Hanus, J. P., & Saliklis, E. (2009). Teaching architects and engineers: Up and down Bloom's Taxonomy. Proceedings of the American Society of Engineering Education Global Colloquium.

Baxter Magolda, M. B. (1992). *Knowing and reasoning in college: Gender-related patterns in students' intellectual development*. San Francisco: Jossey-Bass.

Belenky, M. F., Clinchy, B. M., Goldberger, N. R., & Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind*. New York: Basic Books.

Biggs, J. B., & Tang, C. S. (2007). *Teaching for quality learning at university* (3rd ed.). Maidenhead: Open University.

Boyer Commission on Educating Undergraduates in the Research University. (1998). *Reinventing undergraduate education: A blueprint for America's research universities*.

Boyer, E. L., & Mitgang, L. D. (1996). *Building community: A new future for architectural education and practice*. Princeton: The Carnegie Foundation for the Advancement of Teaching.

Bloom B. S. (1956). *Taxonomy of educational objectives, Handbook I: The cognitive domain*. New York: David McKay.

Chance, S. (2008). Proposal for using a studio formant to enhance institutional advancement. *International Journal of Educational Advancement, 8*(3/4), 111-125.

Chickering, A. W. & Reisser, L. (1993). *Education and identity*. (2nd ed.). San Francisco: John Wiley and Sons.

Christiaans, H. (July 2002). Design knowing and learning: Cognition in design education. (Book review). *Design Studies (23)*4, 433-434.

Duffy, G., & Bowe, B. (2010) *A Framework to Develop Lifelong Learning and Transferable Skills in an Engineering Programme*. 3rd International Symposium for Engineering Education, 2010, University College Cork, Ireland.

Eastman, C., McCracken, M., & Newstetter, W. (2001). *Design knowing and learning: Cognition in design education*. Oxford: Elsevier.

Evans, N. J., Forney, D. S., and Guido-DiBrito, F. (1998). *Student development in college: Theory, research, and practice*. San Francisco: Jossey-Bass.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Journal of Engineering Education, (78)*7, pp. 674-681.

Koch, A., Schwennsen, K., Dutton, T. A., & Smith, D. (2002). *The redesign of studio culture: A report of the AIAS Studio Culture Task Force*. Washington, DC: American Institute of Architecture Students.

Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

Love, P. G., & Guthrie, V. L. (Winter 1999). *New direction for student services*. (88). San Francisco: Jossey-Bass.

MacKeracher, D. (n.d.). Development of Young Adults. http://www.lib.unb.ca/Texts/Teaching/JAN98/mackeracher.html

Marshall, J., Shtein, M., & Daubmann, K. (2011). *SmartSurfaces: A multidisciplinary, hands-on, think-tank*. Presented at the Association of Collegiate Schools of Architecture annual Teachers Seminar.

McKenna, F. F., Froyd, J., King, C. J., Litzinger, T., & Seymour, E. (2011). *The complexities of transforming engineering higher education: Report on forum on characterizing the impact and diffusion of transformative engineering education innovations*. Washington, DC: National Academy of Engineering. http://www.nae.edu/File.aspx?id=52358

Moesby, E. (2005). Curriculum Development for Project-Oriented and Problem-Based Learning (POPBL) with Emphasis on Personal Skills and Abilities. *Global Journal of Engineering Education, 9*(2), 121-128.

National Architectural Accrediting Board. (2009). *2009 conditions for accreditation*. http://naab.org/documents/streamfile.aspx?name=2009+Conditions+FINAL+EDITION.pdf&path=Public+Documents%5cAccreditation%5c2009+Conditions+for+Accreditation%5c

National Science Board, (2007, November 19). *Moving forward to improve engineering education*. http://www.nsf.gov/pubs/2007/nsb07122/nsb07122.pdf

Newstetter, W. C., Behravesh, E., Nersessian, N. J., & Fasse, B. B. (May 2010). Design principles for problem-driven learning laboratories in biomedical engineering education. *Annals of Biomedical Engineering (38)*5.

Perry, W. (1970). *Forms of ethical and intellectual development in the college years: A scheme*. (1st ed.). New York: Holt, Rinehart, and Winston.

Perry, W. (1999). *Forms of ethical and intellectual development in the college years: A scheme*. (3rd ed.). San Francisco: John Wiley and Sons.

Prince, M. J., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education, 95*(2), 123-138.

Sanford, N. (1962). Developmental status of the entering freshman. In Sanford, N. (ed.) *The American College*. New York: Wiley and Sons.

Sheppard, S., Macatangay, K., Colby, A., & Sullivan, W. (2009). *Educating engineers – Designing for the future of the field*. San Francisco: Jossey Bass.

SmartSurfaces. (2010). *Biomenitic SmartSurfaces*. http://www.smartsurfaces.net/fall2010

US Department of Energy. (2009). Solar Decathlon 2009. http://www.solardecathlon.gov/past/2009/daily_photos.html#dp1012

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Integrating Sustainability in a PBL Environment for Electronics Engineering

M. Arsat [a] *, Jette Egelund Holgaard [b], Erik de Graaff [b]

[a]*Universiti Teknologi Malaysia, Johor Bahru, 81310, Malaysia*
[b]*Aalborg Universitet, Aalborg 9000,Denmark*

Abstract

In the past decades, education for sustainable development (ESD) has obtained increasing recognition as a general subject in higher education (HE). Institutions worldwide have had attention to the integration of sustainability into the curricula, and on the conceptual level problem based learning (PBL) has been put forward as a promising pedagogical model and emerged as an opportunity to implement sustainability successfully. Due to the almost forty years of experience in PBL, a case study was carried out at Aalborg University, Denmark to excerpt their experience of integrating sustainability in a problem based learning environment. Three electronics engineering project modules were selected as example and empirically supported by constructed interviews with staff and document analysis of selected material. The findings were analysed with a systems approach and presented with reference to three difference factors: input, throughput and output factors; whereas reflections on the study is presented in the final part. It is found that the PBL practices in the modules comprehend the integration of sustainability in engineering education without compensating technical and engineering competencies as the core contents.

Keywords: Sustainability in Engineering Education; Education for Sustainable Development; Problem based learning;

1. Introduction

In Denmark, problem based learning was founded in the early 1970s by institutionalizing the problem and project pedagogies in two universities, Roskilde University Centre in 1972 and Aalborg University in 1974 (de Graaff and Kolmos, 2007). Learning by doing and experimental learning were two of the central principles (de Graaff and Kolmos, 2007), and the students were to work in collaboration with teachers and others to explore and solve a problem in close relation to the social reality in which it exists (Berthelsen et al., 1977). Thereby, the societal context was a key consideration from the very beginning, drawing from (Mills, 1959) among others and his visions of social imagination.

As such the path to integrate sustainability was established, but it was not before the Brundtland Commission, chaired by Gro Harlem Brundtland, published their famous report “Our common future” (Brundtland Commission, 1987) in the late 1980s that a sustainability discourse was developing at the Aalborg campus. In the 1990s sustainability started to show explicitly in curricula. One of the more comprehensive initiatives were taken by the former study director Mona Dahms, being responsible for a gathered first year of all educational programs at the Faculty of Engineering and Science. In this first year, students were working in inter-disciplinary groups on projects for sustainability. This example still stands as the most throughout integration of sustainability at AAU. Today sustainability is integrated as a patchwork of practices across faculty, whereas management is now determined to gather and develop these practices in order to secure ESD in all programmes.

In this paper, we present a piece of this patchwork of practices at the Faculty of Engineering and Science Aalborg University, to exemplify the integration of sustainability in a problem based learning environment. The case study example is related to engineering education and more specifically electronics. In the following we elaborate on the case, the methodology and the results, whereas we in the concluding part point to reflection that can be of general interests for institutions working with ESD in a PBL environment.

2. Case description – three project modules in electronics and IT

In this paper, three project modules are presented as an example of progression of ESD practices in the Study programme of Electronics and IT. The three project modules emerged as the outcomes from program inventory, which the inventory was designed to identify a module that integrates sustainability. In the inventory process, each of the modules were thoroughly examined on the learning contents such as module objectives and expected learning outcomes i.e. knowledge, skills, and competencies. The project modules are offered for first year student in the first semester and second semester and structured as Problem and Project based Learning activities. Typically, the phases of a project module are that the students, within the frame of a pre-defined project unit theme, formulate an initiating problem (sometimes based on a catalogue of project proposals), then they move to problem analysis and based on that they formulate a narrower problem within pre-defined disciplinary boundaries.

* Tel.: +45-5265 9679 (Denmark)
E-mail address: mahyudin@plan.aau.dk (Denmark), mahyuddin@utm.my (Malaysia)

Taking the point of departure in this problem formulation and a methodological framework, they solve this problem and assess the proposed solution taking results of the problem analysis into consideration.

In this case the three project modules are as follows:

a. Technological project work (P0 - approx. 5 weeks)
   This module is offered to provide students with an insight in a problem based learning environment and at the same time introduce basic concepts and applications in electronics and IT. The problem presented here is rather narrow within a technical frame of mind.
b. Basic Electronic Systems (P1- approx. 10 weeks)
   This module is structured to provide a platform for enabling students to be socialized into the electronics and IT-related engineering disciplines. Theoretical and practical work is combined, taking point of departure in a problem derived from a community or business context. This problem will be analysed by decomposing the problem in sub-problems in order to select and formulate a technical problem that can be solved by using the theories and methods of microprocessor-based systems. The solution has to be an electronic system, incorporating a programmable computer and being able to react to and/or control parts of its outside environment via selected actuators and sensors.
c. Dynamic Electronic Systems (P2)
   In this course students will be through theoretical as well as practical work, based on a selected problem that will acquire knowledge within the electronic and IT related engineering discipline. However, here the students also have to use relevant methods within the field of Science, Technology and Society (STS), that demonstrate that they can contextualize a technical problem including relevant social contexts. Again, the problem will be analysed through decomposition into sub-problems, but in this case the context of the problem in analysed more in depth, which have implication on the formulation of the technical problem. In any case this technical problem has to be solved using electronic systems interacting with the surrounding environment. The final solution will then be evaluated at the end based on evaluation criteria's derived from the technical as well as the contextual analysis.

3. Methodology

In their works, Rompelman and de Graaff have presented the possibilities to analyse the existing world and synthesize `a new world´ with a systems approach, and they also have explored the concept of system approach in an educational context (Rompelman and de Graaff, 2006). The systems approach in this paper categorizes students in the centre of the teaching and learning process. Whereby, the other variables such as course contents are categorized as input factors; abilities, knowledge and skills are considered as output factors; and facilitation and teaching are considered as throughput factors. The reflections on the whole process are then seen as a feedback to re-design the system, see Figure 1.

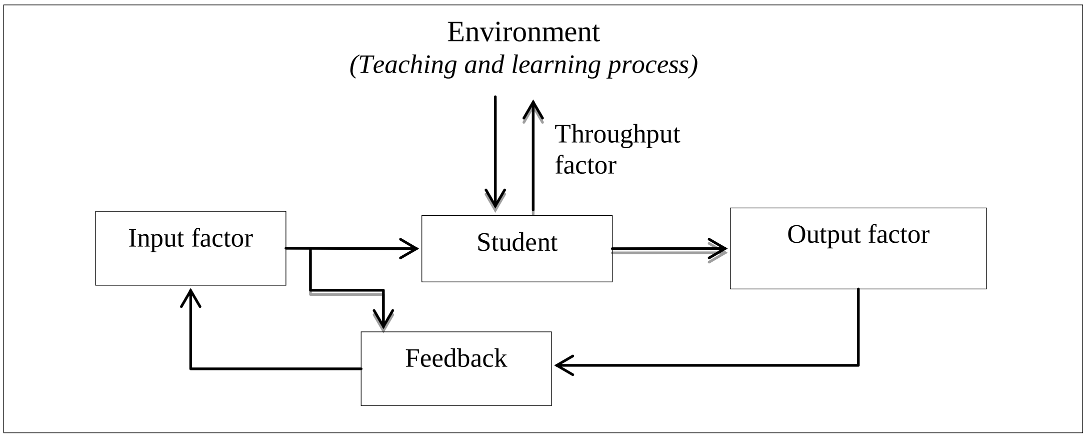

Figure 1. A systems approach for analysing engineering curricula

In the same paradigm, Creemers and Scheerens have used an input-process-output approach, rather specific termed as a context-input-process-output based approach in educational effectiveness research (Creemers and Scheerens, 1994). The system approach in their study instead seem to put the educations in the centre, as the inputs are considered to be students´ background including personal and financial resources, the context is related to educational contexts of schools and socio-economic context, the process or throughput are considered to be the factors within the school, and the outputs are students´ achievements and educational attainment.

In this paper, we lean towards the system approach introduced by (Rompelman and de Graaff, 2006) as the focus is on the educational practice, all though inspired by (Creemers and Scheerens, 1994) to take into consideration broader institutional input factors. Two main data collection techniques were used for this analysis: document analysis and interview sessions. First of all, documented evidence such as electronic and electrical engineering curricula, course/module outlines, students´ assignments and students´ project reports was collected. The key words related ESD (i.e. sustainable development, sustainability, environmental perspective, social/culture perspectives, sustainable technology, green technology) were used to identify the manifestation of the integration in the document analysis. Secondly, four interviews were planned and carried out with teachers, coordinators of the modules and ESD experts. The data were collected from September to December 2012. The interview sessions were structured to identify intangible forms of integration yet not documented and beyond what could be read in the available documents.

4. Results - Factors of integration

In the following we will present three salient "factors" to analyse the way sustainability has been integrated in the programmes of Electronics and IT. Together with the Danish qualification framework, the written statements in the curriculum related to the three project modules in focus, constitutes the input factors. As throughput factors we consider formulation of objectives/requirements, facilitation and team activities during the project period, and finally as output factor, we have considered students learning outcomes represented by project reports.

4.1. Input factors

Input factors are considered as the input for the students in the teaching and learning process environment. The input consisting of all kind of variables related to the structure of program i.e. the electronic and electrical engineering curricula and courses/modules outlines and teaching materials. Besides that, the institutional context of the program structure is also considered as an important input factor, here represented by the Danish qualifications framework.

4.1.1. Documented in Danish qualifications framework

The Danish qualifications framework aims to make the degree structure in Denmark for higher education programs nationally and internationally clarified and transparent. The qualifications framework also describes the desired outcomes and competencies in such a way that it can steer curricula planning. The importance of the qualifications framework is underlined by the inclusion of stakeholders representing universities, non-university programs, students, Danish Evaluation Institute, Danish Centre for Assessment of Foreign Qualifications and employers.

In general, the Danish qualification framework was established based on a model that encompasses i) Competency profiles, ii) Competency goals and iii) Formal aspects. The competence profiles are provided to specify the variety of competencies needed and three types of competencies are defined being i) intellectual, ii) professional and academic and iii) practical.

Intellectual competencies point to general process competencies for intellectual development; being neither specified as disciplinary nor program oriented, e.g. communications skills, self-learning, analytical and abstract thinking (The Danish Bologna follow up group's QF working party, 2003). By this time on the Bachelor level, students have to be able to identify their own learning needs and organise their own learning in different learning environments (Ministry for Science, Technology and Innovation, 2009). This goes well together with PBL and its emphasis on exemplary learning as well as meta-learning.

On the contrary professional and academic competencies are related to a specific discipline or programmes, whereas practical competencies are specifically aimed to the fulfilment of job functions e.g. professional ethics and responsibility (The Danish Bologna follow up group's QF working party, 2003). Even at the bachelor level, the qualification framework state that engineering students must be able to handle complex and development-oriented situations in study or work contexts, and furthermore that they must be able to independently participate in discipline-specific as well as interdisciplinary collaboration with a professional approach (Ministry for Science, Technology and Innovation, 2009). Taking the increasing complexity of technological systems into considerations as well as the increasing focus on environmental management and corporate social responsibility in business, the qualification framework creates an important platform for integrating sustainability in engineering education.

4.1.2. Sustainability related learning objectives in the written curricula for the three modules

All though the Danish Qualification framework provides a platform for integrating sustainability it is not a premise for accreditation that sustainability is explicitly mentioned in the written curricula. This is however the case for the curricula for electronics in relation to the first year as shown in the analysis of the learning objectives, related to the following three project modules.

In the project module entitled Technological project work (P0), the overall objective enables students to describe and apply typical elements of a problem-based project, manage the learning process and provide reflections on this process. The relation to ESD is that the students should be enabled to describe the problem in a holistic perspective.

In the following project module, Basic Electronic System (P1), the course learning outcomes were constructed to provide students with knowledge, skills and competencies related to both electronic system and ESD. At the end of the course, students is expected to understand the basics of electronic systems, but this also includes interaction with the outside world and identification of relevant contextual perspectives including technological as well as societal aspects. The students is also expected to identify requirements for technical solutions based on these contextual perspectives, and furthermore show their ability to manage a project include planning, structuring, implementation and evaluation. In addition, it is stressed that the students have to take point of departure in a problem having societal or vocational relevance.

The last project module on the first year, Dynamic Electronic Systems (P2) is offered at the second semester for electronic engineering students. The module is, besides progress in the understanding of electronic systems, specifically designed to integrate knowledge related to the field of Science, Technology and Society (STS) supported by a subject at the first semester. Students have to obtain adequate skills to analyse and solve a technical-scientific problem taking technological, environmental and also social aspects into consideration in the problem analysis as well as in the assessment of the social and environmental consequences of the proposed solution. Specifically user involvement, stakeholder analysis and analysis of environment regulations are mentioned as areas of interest. In the process of solving the problem, students also have to sharpen their abilities to construct comprehensive models to be used in design, implementation and test of an overall system to assure that the requirements and the desired specifications are met.

4.1.3. Project proposals

As a third input factor, the facilitators provide students with project proposals designed to the learning objectives in the curricula. It is however possible for students to contribute themselves with a project proposal. Project proposals outline the problem-field and the related possibilities to contextualise and develop technical competence within this field. In most practices, the project proposals are constructed in an open way, so the students themselves are formulating the initiating problem and problem formulation.

This input factor could be the most vital element for the efforts to provide education about sustainability in electronic engineering education, as previously highlighted in the introduction, sustainability could in fact be an overarching theme and the project proposals could be developed to capture different aspects of sustainability in relation to the disciplinary field of work. For instance, there was a P1 project, executed by the second semester of electronics engineering students and the project was designed to deal with pupils with disabilities.

In the electronic and IT programme, the proposal can be entirely funded by industries or companies, or the proposal can be prepared specifically for education purposes. Teachers will normally prepare the proposal and present it among a committee or peers including all teaching staff at the semester. The approved proposal will be collected and offered to the students to choose. The students are thereby occasionally triggered with a proposal in relation to sustainability.

4.2. Throughput factors

In the following analysis the throughput factors are analysed in two sections related to i) the student directed team work and ii) the influence by teachers in the facilitation of students´ project work by questioning students, discussions at group/class meetings as well as feedback to students on their writings. These teacher behavioural factors are positively related with student achievement (Brophy and Good, 1986).

4.2.1. Project activities

Throughput factors in terms of project activities have considerable impact on the integration of sustainability in electronic engineering curriculum to maintain the momentum and manifest ESD as a process and not only an input or outputs of engineering projects. The study has identified three possible activities along the process of developing the project or finding a solution that integrates sustainability, that is i) the identification and analysis of problems, ii) product design and test iii) product evaluation.

Early in the process of identifying problems, the students' start out with an open problem and the further analysis of the problem include an explicit focus on the social as well as environmental aspects of the problem. Some of the problems, either proposed by the teacher or students, demand at least a site visit and discussions with stakeholders. During such processes, students will have opportunities to identify related issues regarding the technical problems as well as the related non-technical social and environmental aspects. They also have to develop instruments for collecting data such as interview guidelines and questions for interview sessions with the stakeholders; and in the design of these instruments an explicit focus on sustainability is evident.

Later in the process of designing the possible solution to the now well-defined problem, a specification of the demands to the products can be made based on the conclusion of the problem analysis. All though students often delimit the project by a narrow problem formulation calling for pure technical developments – the students then are aware of the more contextual factors coming into play in real life product development, where departments of environmental and/or health and safety often are involved. In that way they learn how to be specialist in a team and at the same time have enough inter-disciplinary knowledge from cross-departmental collaboration.

In the same line of reasoning, students are, in the last part of the project, asked to make overall assessment of the products impacts on environment as well as society at large. In this phase more strategic management tools as SWOT analysis (assessing the strengths, weaknesses, opportunities and threats) or screening tools (e.g. in relation to environmental assessments) often are in play.

4.2.2. Facilitation

One of the cardinal features of PBL is that the students are at the centre of the learning process, and have to take responsibility for their own learning. The teacher is not telling students what to do, but instead guide them along the process of learning with reference to the learning objectives. Unlike the traditional methods of learning, where teachers usually has full control of learning process and contents, teachers in a PBL environment takes the role as facilitator (Kolmos et al., 2008).

The role of facilitator in a PBL environment is to keep students on track in their projects, so they progress in alignment with the intended learning outcomes. Therefor for the facilitator to make sure that sustainability is integrated in the project work, there have to be a clear reference to the curricula. On the other hand, if the learning objectives do not point to the integration of sustainability, this sometimes unintentionally occurs in the process, due to nature of the chosen problem, which is closely related to the field of interest of students. Based on the learning objectives or student's interest, the facilitator will provide some insight and maybe put some more emphasis on sustainability in the project facilitation.

However, the integration of sustainability challenge the facilitators to have a clear understanding of the subject and as one of the criteria's for accreditation of HE in Denmark is that the teaching has to be research based, this calls for an inter-disciplinary team of teachers. In this specific case, teachers from the Department of Development and Planning contribute with researchers working in the field of sustainability science and Science, Technology and Society (STS). These researchers are involved in a course module at the first semester, and co-supervise the groups in the project module in the second semester.

In the case where sustainability is integrated in the project modules, the facilitators play important roles in motivating the students and help students to open up to other lines of thinking. This sometimes happens, when the facilitators question the conditions of the project or provide suggestions to integrate economic, social or environmental concerns. This often leads to discussions of the role of sustainability in the project and the ways to integrate sustainability in the project without compensating technical competences. This directive approach (with reference to the learning objectives in the study regulations) combined with a collaborative approach is very much depended on students´ motivation, performances and ability to achieve the course learning objectives.

In other cases, students had opportunities to meet external personnel such as engineers and managers from companies to make a network and collaboration on developing their projects. To get in contact with various stakeholders and meet with the target groups or users of the products was a great experience for students to understand their problems and to develop their project. In this way students also have the opportunity to experience, that sustainability plays a role in real life innovation of electronic products.

4.3. Output factors

In a systemic approach, output factors of teaching and learning process are referred to the students´ learning outcomes such as basic skills, other cognitive outcomes and non-cognitive measures (Centra and Potter, 1980) or abilities, knowledge, skills and competences (Rompelman and de Graaff, 2006). In this paper, it is assumed that students´ project report can be analysed as representations of students learning outcomes. Six reports are analysed, two from each module, to exemplify the progression in the integration of sustainability in the first semester of study (P0 and P1) and in the second semester of study (P2).

4.3.1. Students' reports in P0 – getting a sense of electronics and PBL

The analysis of two P0 reports showed that the students have reached the intended learning objectives in relation to PBL and basic knowledge in the field of electronics. The students all had the same project proposal, where they had to develop a robot by use of LEGO mindstorms® (see example in figure 2), that was able to cope with some challenges put forward by the facilitators e.g. carrying items or follow a predefined route. Being able to build something and enter into competitions with each other motivated the groups. However, due to the very fixed technical challenge, it is very hard to find any evidence that the students in fact have had a holistic perspective on their project as intended in the learning objectives.

4.3.2. Students' reports in P1 – the social responsibility project

In the P1 project reports, sustainability solutions are the target, but at the same time reflections or relations to sustainability are not explicit in the report.

In one project, students proposed stimulation tools for pupils with sight and hearing disabilities. Due to pupils´ disabilities, it is vital that the tools have cardinal features such as interaction and strong responses to the user. The strong responses could be in the form of light, sound and vibration. In addition to that the students have to present ideas of activities that combine physical activity with social elements and learning to stimulate the pupils at Centre for Deaf blindness and Hearing Loss, CDH. The project also included i) A study of possibilities for stimulating sight and hearing disabilities based on interviews with employees at CDH and selection of ideas to project development, ii) Preparation of technical specifications for the system iii) Design and construction of a laboratory model, and iv) A testing and assessment product.

The other project considers assistive technology for people with sight disabilities in order for them to manage everyday life. In the project, the students made interviews with representatives from the Danish society for the sight disabled, to point to the most important challenges in the everyday life of blind people, get an overview of the assistive tool already at hand and what demand they this organisation have for assistive technology. Based on that, an interface instrument was developed to help blind people in their use of public transport.

By focusing on the assistive technology, these two projects can be considered as social responsible projects. Furthermore, the real life social problem is carefully analysed by involving the target group and use their input for product design. However, there is no explicit reference to aspects of economic or environmental sustainability; and there is no real trace of sustainability in the approach to the problem analysis and problem solving.

4.3.3. Students' reports in P2 – integration of sustainability

Students report at P2 is clearly influence by the increased and more specific integration of sustainability in the learning objectives and the presence of a co-supervisor with special attention and competences in relation to STS and ESD.

In one of the reports social sustainability play a role in the purpose of the project that is to improve traffic safety by intelligent headphones identifying and amplifying signals of danger. Other projects working with intelligent headphones have instead been targeted at the quality of working environments by reducing noise problems. This is an example of the same product type and basically the same technical learning outcomes related to different types of problems related to different contexts. In the analysis of traffic safety problems the students draw open statistics of traffic accidents and they develop a survey instrument to investigate different types of distraction problems in traffic. Furthermore students measured the amount of noise in traffic and developed a prototype. In the final part of the project, they made overall assessments of the environmental impact from the hardware and estimated the market price.

The other report analysed from P2 have the objective of making a small satellite, which can be used for educational purposes at high school level. Interviews are made with high school teachers and pupils in order to develop an educational set-up around the satellite. Interestingly, student estimated the environmental impact from the satellites as a part of their problem analysis – and thereby before they develop their prototype. They calculate the CO2 emissions to send up a satellite and found that the emission of sending up one approx. equals 1.25 km of car driving. Besides environmental regulation is discussed referring to the WEEE directive (on Waste from electrical and electronic equipment) and the RoHS directive (Restriction of Hazardous Substances). Based on these and more technical consideration a prototype of a satellite is developed.

5. Reflections and final remarks – feedback to create new input to ESD

Even though the qualification framework creates an important platform for arguing that sustainability should play a role in HE, it is not a criterion for accreditation that sustainability is explicitly addressed in the curricula. In a PBL environment this is however crucial, as the learning objectives in the curricula is the frame of reference when guiding students in their learning process. However, bottom up initiatives are also important drives e.g. by staff proposing projects with sustainability focus or students choosing to integrate sustainability in their projects.

However, sustainability cannot be prescribed – it has to be lived, and as such be a part of the project activities and facilitation. Interviews with staff together with analysis of students report points to the conclusion that students do need to be facilitated to maintain the focus on sustainability and at the same time find a way to cope with this relatively complex subject in relation to a specific context without compensating core technical competences. Choosing sustainability in relation to the problem field e.g. by assistive technology for hearing disabled, is one way to integrate sustainability, but from this does not necessarily follow and comprehensive and holistic perspective in the design and implementation of the product. On the other hand the ability to make overall assessments of the environmental, economic and social impacts from a technology should be developed at some time in the curricula, and here the strategy at Aalborg University has been to make sure that co-supervision is provided in the field of STS and ESD. Due to the strong collaboration in the supervisor team, this might also be an indirect training of staff and raise the awareness of sustainability in research environments where this is not considered as the core discipline.

Sustainability has to be included and the aims or goals must be aligned in all three factors therefore the sustainability can be effectively addresses along with the teaching and learning process. The cases have showed that the sustainability was partly in the written learning objectives, dedicatedly discourse in the project activities or facilitation and documented in the project reports. However, there is still a room for improvement where the alignment of the three factors needs to be part of overall assessments. So that, the teachers as well as the students have opportunities to reflect and make improvements in any part of the learning process that insufficiently address the sustainability. We also find out that even though students have showed their abilities to reflect their projects in the perspective of sustainability which commonly documented as a part of the project background and end-of-pipe analyses of project. There was a lack of reflection on sustainability perspective along the process of project development or realization.

However the case-example from Aalborg University shows that, it is in fact possible to integrate ESD without compensating technical and engineering competencies as the core contents. This is however due to a very structured project model, where students gradually work from an initiating and very open problem, through a process analysis phase, whereas they have gained a comprehensive understanding of the problem to narrow this problem to a technical problem to be solve, but still being aware of the limitation of their technical perspectives in a business as well as in a broader societal context. Engineers are not necessarily to become environmental managers or sustainability scientists; but they have to know how to bridge and collaborate inter-disciplinarily in their future profession in order to design sustainable sound solutions. We hope that this paper have provided some insight of the possibilities of making our engineering students ready to take on this responsibility.

References

Berthelsen, J., Illeris, K., and Poulsen, S.C. (1977). *Projektarbejde.* København: Borgen

Brophy, J. and Good, T.L. (1986). Teacher behaviour and student achievement. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 328-375). New York:MacMillan

Brundtland, G.H. (1987). Our Common Future. *Report of the World Commission on Environment and Development.* United Nations

Centra, J.A. and Potter, D.A. (1980). School and Teacher Effects: An Interrelational Model. *Review of Educational Research,* Vol. 50, No. 2, pp. 273-291.

Creemers, Bert P.M. and Scheerens, Jaap (1994) Developments in the educational effectiveness research programme. *International Journal of Educational Research*, 21 (2). pp. 125-140.

Graaff, E. de and Kolmos, A.(2007). History of Problem-based and Project-based Learning. *Management of Change – Implementation of Problem-Based and Project-Based Learning in Engineering* (pp.1-8). Sense Publisher, Rotterdam, The Netherlands.

Kolmos, A., Du, X., Holgaard, J.E., and Jensen, L.P. (2008). Facilitation in a PBL environment. *Publication for Centre for Engineering Education Research and Development.* 2008 Online publikation.

Mills, C. Wright (1959). *The Sociological Imagination.* Oxford University Press. New York.

Rompelman, O. and Graaff, E. de, (2006). The engineering of engineering education: curriculum development from a designer´s point of view. *European Journal of Engineering Education,* Vol. 31, No. 2, May 2006, 215-226.

The Danish Bologna follow up group´s QF working party, (2003). Towards a Danish “Qualifications Framework” for higher education. (pp. 13-15)

Experiences of PBL for Reengineering in Small Business

Yoshio Tozawa*

Advanced Institute of Industrial Technology, Tokyo, 140-0011, Japan

Abstract

We use real business cases in PBL education so that a student can accumulate the experience of business management. The goal of a PBL project is to make a recommendation which brings business values to a cooperation company. Reengineering, or changes of the current way of work, is identified. Understanding of the business of the company is a key to success. If the company is in small business, limited scope of the business helps us to control team activities of the project. But there are still big rooms to think about from variety of business viewpoints. We report for cases of our experiences in PBL education. These experiences clarify what are difficult for students to come up with the important ideas.

Keywords: PBL, reengineering, IT strategy, consulting service

1. Introduction

Our university is a small public professional graduate school founded by Tokyo metropolitan government. We have two master programs, one is Information Systems Architecture and the other is Innovation for Design and Engineering. Problem Based Learning has been introduced as a key curriculum for education. Students are expected to get competencies to work as highly skilled people in real business environment through PBL. Students take lectures in a first year. In a second year students form groups to do projects. One group makes of 3 to 7 members. A theme of project is given to the group by teachers. Group activities are sources for students to learn in the second year. PBL is positioned as a major educational method in our master programs (Tozawa, Kato, 2009).

The author belongs to the graduate course of Information Systems Architecture. The author used to be a business consultant specializing IT strategy. The author wants to teach students what are important in business as a business consultant (Tozawa, 2009, Tozawa 2011). We report our experiences of PBL education and activities for recent two years. We have done four real business cases, one case study in a semester. The project teams consist of 4 to 5 students. All the students have job experiences of several years. The objective of education is for students to learn what are needed to create business values utilizing IT (Information Technology). We hope our experiences could be references to conduct PBL education.

2. PBL using real business cases

The essential theme of our PBL is to create business values utilizing IT. New business values come always from the change of current way of works. IT technology or IT solution alone does not bring business values. Changes of business processes, change of business model, or changes of the current way of works are necessary to bring new business values. Changes can be usually done because of advancement of IT. What used to be considered impossible before can be possible now due to new IT. Business reengineering and IT strategy are two sides of the same coin. Reengineering is essential to advance business values (Hammer, 1993).

Business values depend on the business in which a company is working. In our PBL we need business cases. We ask cooperation companies to provide us the business cases. From viewpoint of a cooperation company our PBL activity looks like management consulting. We ask the company to cooperate with us about 5 months. We have about ten times of meetings during the period. We ask the management of the company to attend the meeting. The management hear our reports or proposal, reviews our activities, and makes any comment. The meeting time is about one hour and half in the evening of week days, since students have full-time jobs.

* Corresponding Author name. Tel.: +81-3-3472-7831
E-mail address: tozawa@aiit.ac.jp

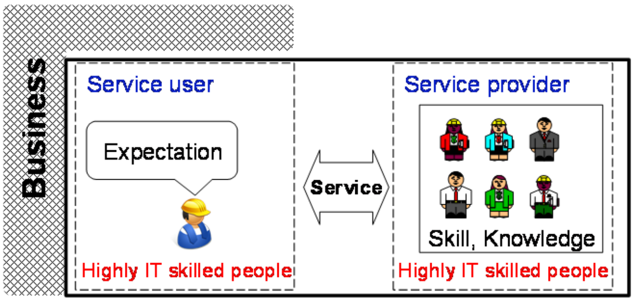

Figure 1. Highly IT skilled people are required both in user side and in provide side. Both people share the same goal to run the business of the enterprise.

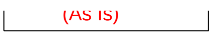

Figure 2. Methodology of business reengineering used in our PBL

Cooperation companies were as follows in these two years.

- Metal plating company (upper half of 2011)
- Home health care massage (latter half of 2011)
- Sales division of life insurance (upper half of 2012)
- Cosmetic dermatology clinic (latter half of 2012)

2.1. Educational objectives

IT industry has been shifting from manufacturing to services business. In Japan highly IT skilled people are short, resulting in fails of many projects. Figure 1 shows where highly IT skilled people participate. There are two main areas, one is service user side and the other is service provider (vender) side. Services are used for service users' business of the enterprise. People in service user and service provider share the same goal to run the business of the enterprise. It seems that the objective of service vender is to meet the requests of service users. However, service users have their own objectives, that is, to meet business requirements to their business of the enterprise.

Though highly IT skilled people have IT knowledge and skills, they are also required to understand business of service users as well. They need to understand what managements of the enterprise think. They should know management priority, business objectives and strategy, and so on. Talk to management is important to capture their thought. Since most students do not have chances to talk to management in their work environment, we provide students with opportunities to talk to management in PBL education.

The success of service business is to meet and exceed the expectation of service users. Understanding of the expectation is very important. Skills required to understand the expectation are sometimes called soft skills, such as, communication skill, leadership skill, and negotiation skill. These soft skills are not taught in most engineering departments of Japanese universities. It is difficult to teach such skills by lectures. Since PBL project is group activities as a team, soft skills can be trained in the activities.

Our PBL activities look like consulting from the management view point of a cooperation company. The management spends time with us in the meeting. In return he/she expects some valuable idea or hints from us. The management usually has some issues in mind, though such issues are not well expressed. Clarification of such issues is one of expectations. It is challenge to discover the hidden expectations. Though these activities are natural to a business consultant, many students may never acquire experience.

When we propose an idea or a recommendation to the management, it is important to judge whether it is accepted or not. How it is accepted by the management can be read by responses, behaviors, or remarks. Accumulation of experience of management response is important when he/she is satisfied with the proposed idea. Our PBL education can provides chances for a student to acquire this kind of experience, which is hard to acquire otherwise.

Students do projects twice in a year using the same methodology. Mastering the methodology is one of the educational objectives. We expect students can apply the methodology when they face the similar situation in the future.

2.2. Methodology

Figure 2 shows our methodology of business reengineering used in the projects of PBL. The methodology is independent of industry. Industry knowledge is not prerequisite to reengineering. Logical thinking is much more important. The final goal of the project is to come up with the state where the management of the company makes decision to change the current ways of work. The project team makes a final presentation at the end of the project to persuade the management.

Step 0 is the initiation of the project. The cooperation company is determined. The team members understand each other well. Team characteristics are identified, such as, what are strong, what background we have. Members agree the objective of the project. At this point they don't know the concrete objective, since no meeting with the cooperation company is held yet. All the available information related to the company is collected in preparation. Meanings of the company specific terms are investigated to avoid misunderstanding. This kind of preparation is important to understand adequately what the management of the company says at the first meeting.

Step 1 is to understand the business of the company. The main source is the meeting with the management of the company. In the first meeting the management explains their business, that is, what is doing, who is the customer, history of the company, what they want to do, what are issues, and so on. A couple of meetings are held to confirm that the team understands the company business appropriately. The business strategy is identified. The business environment and industry trend are investigated.

In consultation of business reengineering, we seldom make a proposal to business strategy. Business strategy is usually given. We create proposal for reengineering or IT strategy which is aligned with the business strategy. Alignment of business strategy and IT strategy is important. In this sense logical thinking is important while industry knowledge is not so important.

Step 2 is to identify issues. The management may make some comments on the issues which are in mind. Such comments are very important because they express how the management views the business. Some issues raised could be superficial. Our goal in the step 2 is to identify the root issues which cause the superficial issues.

Business processes are clarified and modeled. How business is done is analyzed. Since the way of business is a matter of course for the company, business processes are sometimes not well under conscious. Any business process has its objective. It is discussed whether the process meets the objective. Once the business processes are modeled, it is easy to communicate and to share what are wrong or what can be improved in the current way of work.

In order to approach the root cause from superficial issues we use the thinking process of hypothesis and verification. Most superficial issues usually have some measures to avoid troubles. Such temporary measures may hide the problem but do not solve the root problem. We need to identify the root cause of issues to solve. Analysis is useful to approach the root cause. Though analysis is good, we suggest building up the hypothesis of the root cause. Some students are not familiar with the thinking process of hypothesis and verification. They are trained how to approach the root cause.

If IT systems does not support the business processes appropriately, IT system issues are listed. When the systems were built at first, the system could not have capability to support the business processes. Since IT is advancing, IT can support the business processes now. IT system issues are identified from the viewpoint of current IT capability.

Step 3 is to sketch the picture of ideal (To-Be) state of the business. This is a goal to attain which is shared by the management and employees of a company. The picture reflects the thought of the management. The picture should clarify the strategy. Step 3 is not a solution of issues. Step 3 does not directly connect to step 2. Rather it connect to step 1.

Step 2 clarifies the current status quo with issues (As-Is). Step 3 clarifies the ideal goal to attain (To-Be). Step 4 defines what to change so that the company can reach to the goal from the status quo. Step 4 is essential for the management to make decision of change.

Change principles are defined at first. There are usually many things to change. However, points to change should be easily memorized and shared by the management and employees as a strategy. Number of points to change should be limited to several. Each point to change is an action to do for change. One chart is drawn for each point to change to clarify what to change. We use a template of the charts (Figure 7 is a sample). Left hand side of the chart shows As-Is while right hand side of the chart shows To-Be. The change is easily understandable from left (As-Is) to right (To-Be).

Step 5 is a final presentation. Consistent simple story is needed to persuade the management to make decision. A logical consistent story is made up as a strategy. All the elements of activities done in previous steps are summarized.

This presentation is a little bit different from that for general audience. In a presentation for general audience all the elements of logic must be clearly stated. However, in a final presentation to the management, some elements can be omitted, since the management knows his/her business well.

The message of the final presentation may not sound new. It looks trivial from general common sense. However, it is meaningful if it fit to the business of the company.

2.3. Project team operation

The project team consists of 4 to 5 students. One student is assigned as a project manager role. Meetings with the cooperation company are scheduled roughly once in two weeks. Just after each meeting, the students get together at near coffee shop to record what they hear at the meeting before they forget. The next internal student meeting starts with the review of the last cooperation company meeting using the record.

After the review of the last meeting, we decide what we bring at next cooperation company meeting. This determines the activities by next visit. Detail schedule of activities is planned about for two weeks. Rough plan of activities comes from the methodology. But detail plan is created every time after the cooperation company meeting for next visit. Interestingly this practice is very much like scrum software development process (Schwaber, 2010). Practice of management consulting is always adjusting activities to client intention. There are common principles both in agile software development (Takeuchi, 1986) and consulting practice.

Several team meetings are held before visiting the cooperation company. 6 to 8 hour team meeting is held on Saturday. 3 hour meeting is held once a week in weekday evening. Each student is assigned homework to the next meeting. It takes about 3 hours to complete the homework. The subject of homework is decided by the supervisor (the author) or the project manager.

Since the project is to conduct consultation, team discussion is encouraged to reach better ideas. Outcome of the homework becomes a start line of the discussion. Subject of the discussion is given by the supervisor. The supervisor reviews the contents after team discussion of a couple of hours. Quality of discussion contents is critical in consultation. If the supervisor does not satisfied with the contents, he gives students hints to think. The team discussion is repeated. Time of discussion is not so important from educational point of view, rather contents of discussion are important. The supervisor must be patient to wait.

If some ideas come from the discussion, the supervisor let students to present them to the management of the company. The management makes judgment whether they are acceptable of not. Students learn the required quality level to get accepted from the response. The supervisor lets students to learn for themselves. The supervisor controls the quality so that the management may not feel waste of time.

Students always prepare charts for the meeting with the management to communicate their messages adequately. Skills to draw charts are well trained as well. Though chart creation is divided to each student, message creation is cooperative activity.

2.4. Evaluation of students

Evaluation of students in PBL is always difficult. Students mainly learn by doing activities in the project. Activities assigned to a student vary depending on a situation of the project. A teacher cannot control well the assignment. What a student learns may be different from what a teacher wants the student to learn.

In this particular PBL we evaluate a student from two aspects, one is the extent of any contribution to the project and the other is the extent of ideas which bring value to the cooperation company. Some students are not good at putting forward an idea. Even if the extent of idea is short, the extent of contribution as a whole is evaluated. The supervisor is watching students' activities so that he can evaluate appropriately. As two other sub-supervisors evaluate students as well so that the evaluation of the supervisor might not get out of common standard.

3. Actual cases

3.1. Metal plating company

3.1.1. Background

The cooperation company is in small business with special technology of particular metal plating. The number of employees is about 30. The president of the company is very aggressive. He thinks that recent IT has big potential power to contribute even to small business. He asked us that any opportunity of utilizing recent IT. He knew conventional application development which sometimes resulted in the rigid functionality. Once an application is built, it is difficult to adjust it to the changing environment. He thought that the recent IT could overcome such the rigidity.

The president has a firm faith that every people have a good potential capability. If such capability is well developed, the company becomes strong. IT can help develop the capability.

3.1.2. The first pitfall

Figure 3 shows the business of metal plating company. It was really hard work to complete Figure 3. The company is classified in the category of parts makers. In general a parts maker manufactures parts and provides a customer with parts. Parts can be stocked. However, the metal plating company does not manufacture parts, even in the case of new parts. New parts are manufactured by other company. The new parts are brought in to the company for metal plating. The plated parts are shipped to the customer. There is no stock of parts in the company. Though the company belongs to manufacturing industry, the essence of the business is service of plating.

Service business view is much more important than manufacturer view in understanding the business of the company. The change of thought was required. But it was very difficult because bias in favor of manufacturing was very strong. Figure 3 was an initial key chart of step1. It took a couple of days to complete it until students understand the business as service.

This example shows that it is very difficult for student to grasp the business appropriately. The management told us their business and how they operate thoroughly. But students could not understand them correctly. Preconception of manufacturing industry prevented students from the idea of service business.

It is very important to understand business. Without right understanding of business, it is difficult to find issues.

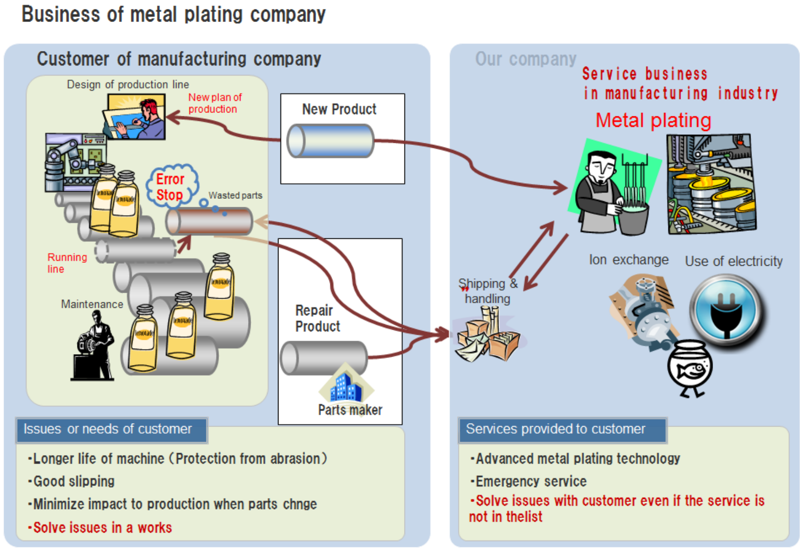

Figure 3 Business of metal plating company

Teacher as a supervisor let the students discuss the business of the company several hours at first. But their discussion didn't approach the right direction. He raised several questions so that students could realize the right direction. Some components of Figure 3 came from the answers of the questions. After all components are put up to Figure 3.

3.1.3. Ideal state of business and Points to change

Figure 4 shows the ideal state of business (To-Be) in step 3 and three points to change in step 4. We have discussed a lot with the president. He thinks that the basic of company strength comes from employee. If each employee exhibits his potential well, the company becomes stronger. Every employee has thinking capability. If good input for think is supplied, employees can think for themselves to improve something.

Information should be provided as company asset. Good and faster communication among employees in different divisions is important. Motivation of employees must be kept high. Though each of these sound trivial, it is important for the president to realize and confirm these.

The president accepted and appreciated Figure 4 when presented. The president took some actions after our final presentation to the cooperation company. This was the sign that our activity brought value to the company.

A value to the company varies from company to company. There are many things said what should be done in general. But identification and prioritization to do is important. This comes from understanding of business and discussion with management. Indeed Figure 4 seems trivial for some, but it has value for the particular company.

This kind of experience is important to learn. We believe that we succeeded PBL education in this sense in this case.

3.2. Home health care massage company

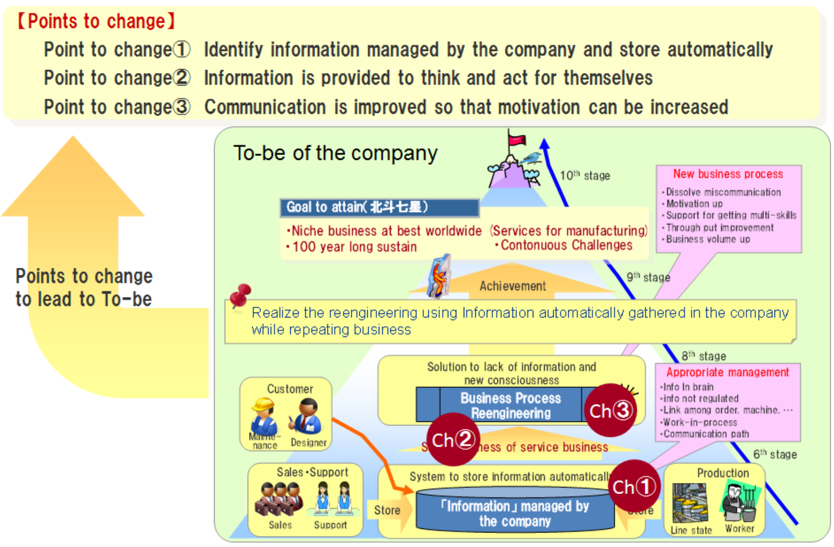

Figure 4 Three points to change with To-Be stage of the company

3.2.1. Background

The company was introduced by the president of metal plating company. In Japan home health care massage became a subject of health insurance about 15 years ago. The president established the company and entered the new service market of home health care massage since then. The company has grown rapidly. There are about 60 stations nationwide now. The number of staffs is about 500.

The president has several concerns about the growth of the company. For example, he has confidence to grow from 1 to 10. But he does not have good confidence to grow from 10 to 100. Once the company becomes bigger, the operation must be changed from that of small size.

The president told us his vision, business strategy, what he has done, and his concerns. Our team tried to respond the concerns that were expressed at the meeting. We investigated several books, web, and materials. We reported what we investigated with our comments. These activities were well accepted. As activities were many, we divided the work into two smaller groups (two to three students).

3.2.2. Structure of concerns

We used strategic capability network as a tool to figure out capabilities which support business strategy. This activity led the CSFs (critical success factors). CSFs were part of our recommendations. Figure 5 illustrates the relationship among vision, business strategy, business model, and CSFs. CSFs are written in white circles in lower half. There are many similar concepts, such as, vision, business strategy, business model, and company ideology. The president talked us about these. Each of them is important. But it was a little bit difficult for us to understand as a whole. This impression triggered to draw Figure 5 for arrangement of thought. The president has thought about these a lot. In a discussion at the meeting, the president got stimulated from us. He got new insight from our report and discussion. The discussion eventually brought values to the president. Figure 5 is one of the summaries of our activities. Students acquired very good experience. They learned what the management responds when satisfied.

3.3. Sales division of life insurance

3.3.1. Background

The goal is obvious to increase sales of life insurance by life consultants. Their basic business model was established more than 100 years ago. A life consultant asks a new client to introduce prospects. A list of prospect is an essential asset for the life consultant.

A manager of sales division of a life insurance company thought that there could be another business model, since IT has been advanced and IT has impacted society so much. He provided us the case.

3.3.2. Difficulty of logic creation

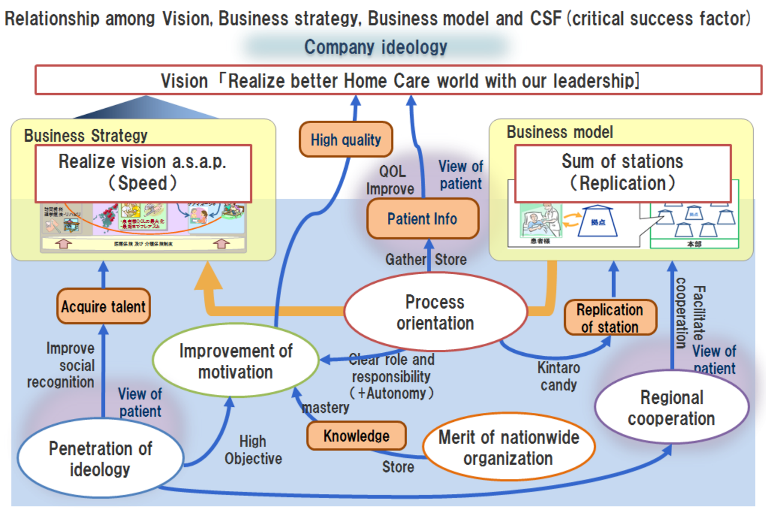

Figure 5 Structure of president concerns and our recommendations

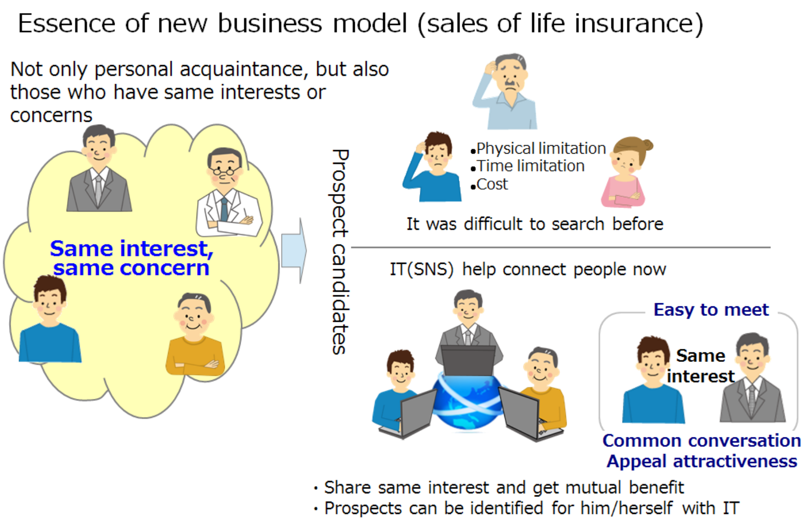

Figure 6 New business model to get prospects for life consultants

We have more than dozen of meetings with the manager. Each meeting was about 2 hours. Student team often failed to deliver good values to the manager. Since he was not satisfied the contents of presentation, he gave us many suggestions. Teacher did not give students clear advice to overcome the situation. Teacher thought that students should realize the cause of difficulty. Eventually the planed final presentation has been postponed, because quality of contents was not good.

Students had already enough elements of contents for presentation. They lack the key logic for persuasion. Figure 6 is the chart which is added after postpone of final presentation. Students had implicitly noticed that same interest or same concern were key. But they have never explicitly expressed it. There is common recognition that attractiveness of life consultant results in the success of sales. Adding Figure 6 with the story for success of sales, students completed the final presentation. Most of charts were the same at the time of postpone. Contents were not changed. Logic was explicitly added and clarified.

At the final presentation the director of sales division gave us very good comments. After all final presentation was successful. Students have experienced that a little difference turned out the success.

3.4. Cosmetic dermatology clinic

3.4.1. Background

The company was introduced by the president of home health care massage company. The employees of clinic are 7 other than the doctor and the president (wife of the doctor). When the clinic opened in 2000, cosmetic dermatology clinic was very new in Japan. There were so many customers that they had to wait 3 to 4 month to get treated. Since then business environment has changed. Many competitors appear. Behavior of customers changes. The president asked us any improvement of their business.

The president expressed issues from her perspective. The clinic does not provide functions to make a reservation through web home page. How can the clinic achieve the best balance between resource capacity and customer needs? In summer some customers have to wait 2 to 3 months, while in winter resources sometimes become idle. These are very natural observations. We tried to approach the root cause of issues.

We analyzed their business and their business processes. During the meeting with the company the president has noticed the problems which can be easily solved. Some actions were quickly taken which were triggered by our activities. Students were glad to get direct response.

3.4.2. Change the way of booking

One of root issues we identified is booking (make a reservation). It is natural that booking time is the time a customer requests. But it does not fit to the case of this clinic. We simulated how the requests conflict if we accept customer request time. The result was about 50%. This number matches the feeling of receptionist. Since this number is big, there could be potential customers who give up to get treated by this clinic. The smaller conflict occurs, the better. This issue was not well recognized until we pointed out.

Analyzing reservation records, we found that 3 slot reservation holds more than two third. In order to reduce conflicts, reservation should be arranged so that 3 contiguous slots may be left. This led the change of thought that the booking time is not the customer request time but the recommended time by the clinic. The recommendation can be controlled easily by guide boarders.

Figure 7 shows this change as one of points to change. As objective of the project is to change the way of work, new way of booking fit to this. If IT support is available, there are additional services become available. Figure 7 shows these potential services, one of which is web reservation.

3.4.3. Crucial influences of PBL activities

The president of the clinic said;

"I had never thought that the clinic (operations of the clinic) could change. Now I find even the clinic can change."

One of the students said;

"I am able to feel happiness when I see that the client becomes happy through our consultation and when the client says 'thank you.'"

4. Discussion

All the students of these PBL projects have work experience. Even though students have work experiences, it is still hard for them to grasp the business exactly. All the aspect of business is not explained or described. Some business processes must be compensated by hypothesis. The hypothesis must be checked whether it is right or not. Students are not well accustomed to this type of thinking process.

Appropriate understanding of business is essential to bring business values to a company. If a company is in small business, scope of business is limited. I think it is easier for a student to understand the business. But there is variety of viewpoints to approach the business values even in small business.

Real business case projects provide a student with particular experience which could be hard to acquire in current daily jobs. A little difference turns out the success or the failure of projects. Though it is said that there are many things to learn in failure, I believe that success experience is also very important.

Conversation with the management gives students with insights. Direct response of the management to a proposal or a comment guides students for direction. Discussion with the management brings the different ways of thinking. I believe that it is important to provide opportunities where students meet directly with the management.

References

Tozawa, Y., Kato, Y. and Chubachi, Y. (2009), Efforts to ensure the quality of PBL education in the graduate school of Information Systems, *Proceedings of the 2nd International Research Symposium on PBL 2009*, Victoria University, Melbourne, Australia.

Tozawa, Y., (2009), IT strategy education through project based learning, *Research on PBL Practice in Engineering Education*, Sense Publishers, (Chapter 14)

Tozawa, Y. (2011), Case studies of education in business process reengineering through PBL, *Proceedings of the 3nd International Research Symposium on PBL 2011*, Coventry University, UK.

Hammer, M., and Champy, J. A.(1993), *Reengineering the Corporation: A Manifesto for Business Revolution*, Harper Business Books, New York

Schwaber, K. , & Sutherland, J. (2010). *The Scrum Guide*, Scrum.org.

Takeuchi, H., & Nonaka, I. (1986). The New New Product Development Game. *Harvard Business Review*.

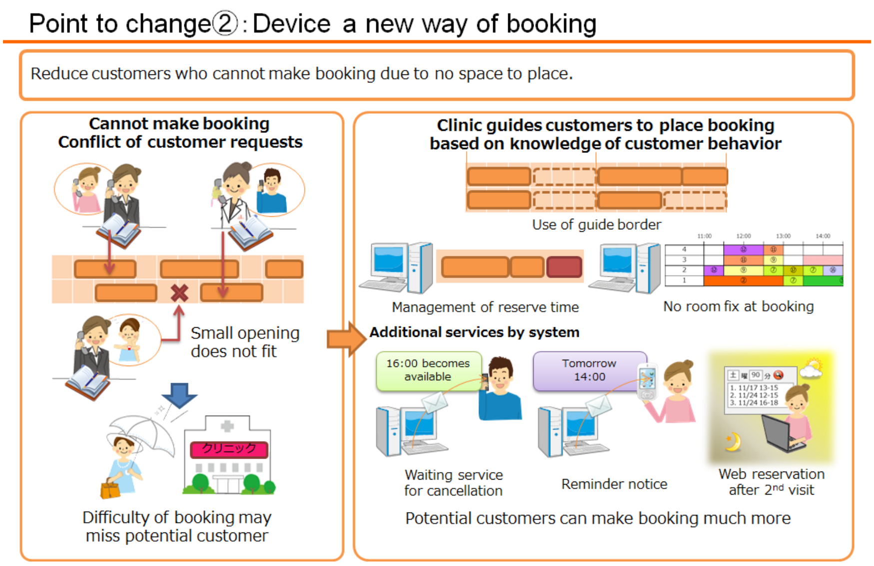

Figure 7 Booking time is not the customer request time but recommended time by the clinic.

FILA-MMS Chart in Chemistry PBL Lesson: A Case Study of Its Implementation During Problem Analysis

Tan Yin Peen [a *], Mohammad Yusof Arshad [a]

[a]*University Teknologi Malaysia, 81310 Skudai, Johor, Malaysia.*

Abstract

Problem-Based Learning provides a platform for Malaysia to develop quality human capital. It is crucial to nurture students with skills and capabilities since schooling years. Chemistry is also an important subject which enables learners to understand the world around them at three levels of representation: **Macro**scopic, sub**Micros**copic and **Symbolic**. In this research, the FILA chart has been redesign into FILA-MMS chart. A case study is carried out on the problem analysis and learning process that utilized this chart. Findings show that there are three phases of the process: teacher explanation, group discussion and class discussion. Students' work are also reviewed.

Keywords: Problem-Based Learning, FILA chart, Chemistry education, Multiple levels of chemical representation.

1. Introduction

Malaysia aims to achieve the Vision 2020 to be a developed nation in the year 2020. However, Malaysia is still lacking behind in terms of economy, infrastructure, technology and communications, health, education and innovations in comparison with developed countries (CIA World Factbook 2011, 2011; Schwab, 2011). In this globalized era, Malaysia faces strong worldwide economic competition and challenges. Education plays an important role to nurture students to be in line with the demands and challenges of the 21st century.

Education in many countries, such as the United States, countries of Europe, Australia and even countries in Asia have been emphasizing on capacities and attitudes extending beyond content knowledge. Problem-based learning has been implemented widely and is advocated for the development of 21st century skills and capabilities. However, conventional teaching style is still very common in Malaysian science classroom. Teacher acts as the information purveyor and students passively receive. Students focus on memorizing content knowledge and are unable to solve real problems. A shift in Malaysian education pedagogy to PBL has a high potential to develop students who are equipped with qualities to survive and excel in the competitive 21st century.

1.1. Problem-Based Learning (PBL)

Problem-based learning (PBL) is a pedagogical approach that promotes holistic learning, emphasizing on skills and capabilities beyond content knowledge. PBL centered on ill-structured real world problem and encourages the practice of information-gathering, reasoning and problem-solving skills, interpersonal and team working skills, as well as the acquisition of content knowledge, in the process of working out the problem in collaborative groups.

There are three major learning objectives (Barrows, 1985) in medical PBL, which are to acquire and develop retrievable and usable knowledge base, reasoning skills; and self-directed learning. According to Hmelo-Silver (2004), the goals of PBL are similar to the ones mentioned by Barrows, with addition of two goals, which are to develop collaboration skills and intrinsic motivation. Many studies (Albanese & Mitchell, 1993; Bilgin, Senocak, & Sözbilir, 2009; Dochy, Segers, Van den Bossche, & Gijbels, 2003; Newman, 2003; Norman & Schmidt, 1992; Vernon & Blake, 1993) have been carried out and PBL has been proven as an effective pedagogical method for holistic learning.

PBL is a prominent instructional method in medical education and other programs in tertiary education in many countries. However, PBL is still in its preliminary phase in Malaysian universities. In spite of all the benefits of PBL, most lecturers are still prone to lecture-based instructional approaches (Berhannudin M. Salleh, Hussain Othman, Ahmad Esa, Abdullah Sulaiman, & Hasyamudin Othman, 2007). Researchers commented it is challenging for lecturers to utilize PBL due to the fact that most students entering university are not prepared for active learning as they come from a passive, spoon-fed and exam-oriented schooling system (Hussain Othman & Berhannudin M. Salleh, 2009; Khairiyah Mohd Yusof, Syed Ahmad Helmi Syed Hassan, & Zaidatun Tasir, 2009).

There is limited research found about using PBL in Malaysian secondary schools even though there is an increase interest worldwide to implement PBL, even in K – 12 educational settings. Conventional teacher-centred teaching is still dominant in Malaysian society and students are lacking of higher-order thinking and generic skills (Abu Hassan, 2003; Anuar Zaini et al., 2003; Lim, 2007; Lim, Fatimah, & Tan, 2002; Sharifah Maimunah, 2000). PBL provides students with the opportunity to develop the skills they needed to strive in the 21st century. Thus, it is crucial to nurture students since their schooling years. In this study, PBL is introduced into secondary school chemistry lessons.

[*] Tan Yin Peen. Tel.: +6-017-370-1678
E-mail address: yinpeen@gmail.com

1.2. Multiple Levels of Chemical Representation

Chemistry is an important subject. Our everyday life involves chemicals, reactions and phenomena related to chemistry. Learning and understanding chemistry aids our understanding of the world we live in. Chemical phenomena can be described at multiple levels of representation which are interconnected and related in terms of information. There are three levels of chemical representations, namely the macroscopic, submicroscopic and symbolic levels (Gilbert & Treagust, 2009; Chandrasegaran, Treagust, & Mocerino, 2007; Treagust, Chittleborough, & Mamiala, 2003; Johnstone, 1991). The abilities in making sense of concepts at each level and transferring knowledge between the three levels are essential towards developing a better understanding of chemical phenomena and the underlying chemistry concepts (Kern, et al., 2010; Treagust, et al., 2003).

The macroscopic level of representation is the perceptible properties or phenomena encountered in daily experiences or laboratory experiments (Gkitzia, Salta, & Tzougraki, 2011; Gilbert & Treagust, 2009; Treagust, et al., 2003). For example, changes in state, changes in color, temperature and pH, decomposition of reactants and formation of products in chemical reactions. The macroscopic phenomena can either be of one's direct experiences or from secondary sources, such as videos or pictures. At the submicroscopic level, matter is represented as its constituent particles (e.g. atoms, molecules, electrons and ions) that are too small to be seen. Particulate diagrams and molecular models are used as the representations of submicroscopic level (Gkitzia, et al., 2011; Kern, Wood, Roehrig, & Nyachwaya, 2010). Submicroscopic level representation assists in visualization of molecular concept as well as mental model development for the concept, and it is important to enhance conceptual understanding of a chemistry concept (Gilbert & Treagust, 2009). The symbolic level of representation involves the use of chemical formulas, equations, molecular structure drawings and graphs with symbols, letters, signs and coefficients. It is use to depict molecular structure, chemical phenomena and the interactions of particles, as well as entities involved in a chemical reaction and their physical properties (Gilbert & Treagust, 2009; Kern, et al., 2010; Chandrasegaran, et al., 2007).

The multiple levels of chemical representation have been identified as a source of difficulty to learning chemistry. One of the major reasons is that teachers often jump rapidly from level to level within this triangle in their teaching, without highlighting the differences and interconnections between the levels (Johnstone, 1991). Teachers either do not integrate multiple representations in their chemistry instruction or do not connect the levels sufficiently (Devetak, Urbančič, Grm, Krnel, & Glažar, 2004; Gabel, 1999). Instead, chemistry teaching takes place primarily at the symbolic level, which has received much more focus and emphasis (Gabel, 1999). As a result, students are not aware of the existence of the three different levels in their chemistry learning. Students whom are new to the subject chemistry are not able to follow the teacher's pace and get confused easily as they fail to integrate between the levels. Students often have the ability to solve problems at the symbolic level, such as balancing of equation, but have little understanding of the basic underlying concepts and principles, and thus could not provide explanations of the phenomena at the submicroscopic level (Gkitzia, et al., 2011; Hinton & Nakhleh, 1999).

Thus, for better understanding of chemical concepts, the multiple levels of representation should be emphasized as an aspect to look upon on in chemistry education (Gilbert & Treagust, 2009; Mocerino, Chandrasegaran, & Treagust, 2009; Devetak, Urbančič, Grm, Krnel, & Glažar, 2004). In this study, multiple levels of representation is given emphasis in PBL lessons.

1.3. Problem-Based Learning and Multiple Levels of Representation

In the literature on PBL for chemistry, the multiple levels of chemical representation have not been an emphasis in the chemistry lessons. The PBL lessons generally focus on real life problems and the practice of generic skills in the problem-solving process. Even though the development of skills is important in PBL, the understanding of chemistry from the three levels of representation is as well important in a chemistry lesson. The teacher plays a crucial role in guiding students to realize the existence of the three levels and their importance in order to understand chemistry concepts thoroughly.

In addition to mastering conceptual content knowledge, education in the 21st century also emphasize on nurturing generic skills among students to prepare them to function well in the 21st century society. PBL serves well as an instructional method to obtain both content knowledge as well as generic skills. Thus, in order to get both benefits of PBL and the multiple levels of chemical representation, this study integrates the three levels of chemical representation into the FILA chart. FILA chart is a thinking tool used in PBL to approach problems systematically. The template helps student to think through and identify what they know from and about the problem, as well as what they would need to know and do in order to solve the problem. In this study, a chemistry teacher used the adapted version of the FILA chart in his implementation of PBL lessons.

1.4. FILA-MMS Chart Adapted From FILA Chart

In this study, the FILA-MMS chart (Figure 1) has been developed to integrate the multiple levels of chemical representation component into PBL. From FILA chart, the Ideas Column is divided into three sub-columns for macroscopic level ideas (**M**acro), submicroscopic level ideas (**M**icro) and symbolic level ideas (**S**ymbolic), thus the addition of **-MMS** to FILA. Macro Sub-column in FILA-MMS is similar to Ideas Column in FILA. The differences between the charts are additional ideas at the molecular level (Micro Sub-column) and related formulae and equations in the Symbolic Sub-column. Facts, Learning Issues and Action Plan Columns remain the same

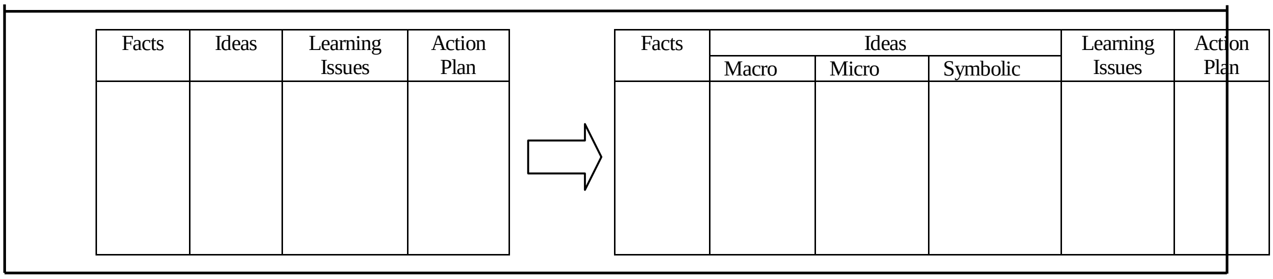

Figure 1. FILA Chart to FILA-MMS Chart

Table 1. FILA-MMS Chart Explanation

Column	Explanation
Facts	Information extracted from the problem scenario; grouped according to themes where possible.
Macro Ideas	Any ideas about the problem, based on facts identified; brainstorm; hypotheses – accepted without judgment, evolves over time. (Things you know about the information extracted and suggestions for possible solutions.)
Micro Ideas	Theory at particulate level (atoms, ions and molecules) and/or submicroscopic representation diagrams of chemical reaction or physical process involved (when applicable)
Symbolic Ideas	Equations of related reactions (when applicable)
Learning Issues	Things you need to know or find out to solve the problem; Phrased as questions; when answered should contribute towards solving the problem
Action Plans	Activities to be carried out to answer gaps in order to help solve the problem, e.g. conduct research, interview; questions/info to be sought from the parties in the scenario. (How to find the needed information.)

With the insertion of the three levels of chemical representation in FILA chart, students categorized their ideas into the three levels when analyzing the problem. Not only the students become aware of the specific levels of their ideas, they are encouraged to think at each level in order to fill up the chart. Table 1 show the explanation for each column in the FILA-MMS chart, which is inserted in the student's module.

2. Objective

This study integrated multiple levels of chemical representation into problem-based learning by redesigning FILA Chart into FILA-MMS chart. Then, the PBL approach using FILA-MMS chart is introduced into Malaysia secondary school chemistry lesson.

The objective of this study is:

To explore how teacher implement FILA-MMS chart during problem analysis in PBL.

3. Methodology

This study used a qualitative approach of case study. The purpose is to obtain detailed insights into a teacher's implementation of PBL using FILA-MMS chart during problem analysis step. The researcher participates as a passive observer. Data is gathered through observation and video-recording. Data are transcribed and analyzed using content analysis.

Teacher Lim (pseudonym) participated in this study on a volunteer basis. He has a degree in Chemistry and Diploma of Education. He has been teaching chemistry for four years. Teacher Lim's usual chemistry teaching styles before embarking on PBL instruction are chalk and talk, use PowerPoint slides, give students notes, focus on exam questions, and use questioning while teaching. The researcher conducted a PBL Introductory Session for Teacher Lim a month before the PBL lesson. Teacher Lim is given the PBL lesson materials and a teacher's guide. A follow-up discussion session is held on the week before the PBL implementation.

Teacher Lim selected one of his Form four (Year 10) classes to participate in this study. The class selected is the top class of form four science classes. There are thirty five students, comprising of 21 female students and 14 male students. There is a mixture of different races in the class. The students are divided into five groups with seven members each for the PBL lessons.

4. Results and Discussion

From the analysis of the lesson's transcript and the video-recording, the implementation of FILA-MMS chart during problem analysis step in PBL occurred in three main phases: 1) teacher explanation of FILA-MMS chart, 2) group discussion and group work, and 3) class discussion on FILA-MMS chart. This section describes and interprets the teaching and learning process in each of the three phases. Two students' work (FILA-MMS chart) from different groups is analyzed.

4.1. Teacher Explanation of FILA-MMS Chart

The students are new to both PBL and the concept of multiple levels of chemical representation. Thus, Teacher Lim started the problem analysis discussion by introducing the FILA-MMS chart. First, the teacher explained the 'facts' column by reading the definition given in the module and gave an example of a fact. He asked students to list out other facts later. Then, he repeated the definition of 'facts' using his own phrase.

Teacher Lim proceeded to 'ideas' column and explained that 'ideas' is divided into 'macro', 'micro', and 'symbolic'. He explained the meaning of 'macro ideas' with some difficulties and ended up purveying the wrong concept to students that 'macro ideas' is any possible solutions for the problem. Supposedly, it can be any possible solutions together with other ideas about the information extracted from the problem. Teacher verbatim as below:

"So the 'macro' here is the idea about the problem based on facts, okay, it's a brainstorming. Okay? Anything that ah/ Any possible/ Okay it means that, let's say, for example, for this one the problem here, any possible solution that you can think of, that's the idea."

Teacher Lim reinforced the wrong concept of 'macro ideas' definition by giving three examples of possible solutions.

The teacher proceeded to explain 'micro ideas' in his own words, giving a description which is misleading:

"Then the 'micro' is more to the molecule, is more to chemistry, molecule. Let's say examples, coke can corrode the teeth, what are the molecules that involve? What are the chemicals in the coke? That can corrode the teeth? More in detail into chemistry."

The teacher was not able to explain clearly the definition and distinction between macro and micro level. Teacher misled students to think that 'chemicals involved' are 'micro ideas', whereas micro level should also involve visualization of the particles. Pure descriptions of chemicals in the coke that can corrode the teeth are supposed to be 'macro ideas'. Even though the idea conveyed is unclear, the teacher used questions to provide an idea of the examples, instead of providing the examples directly.

Following Teacher Lim's statements and questions, students are talking and giving opinions. The teacher paused for some time before directing students to the reading materials and resources at the end of the student module. He told students to read from there to get information and the solutions. Then, Teacher Lim proceeded to the 'symbolic ideas' and explained them as 'equations', gave examples of relevant reactions and chemicals involved, and asked for their equations. He then explained 'symbolic' again as 'symbol' and 'all molecule formula'.

Teacher Lim continued to explain 'learning issues' by reading part of the definition. A student raised her confusion by questioning the teacher. The teacher answered the student directly by providing two examples of learning issues. Teacher explained that students just need to write down the questions in the column. Teacher continued to explain with examples and told students that they are to find the answers based on the questions that they list down. Teacher then explained on 'action plans' and provided two examples. Teacher Lim rounded up this phase by telling students that he had just explained what the students should write in the chart.

From the analysis, it can be concluded that Teacher Lim's explanation of FILA-MMS followed a certain pattern: Teacher explains each column, gives example(s) following his explanation, and repeats the definition for the column. Teacher Lim continued from one column to another, without pausing in between for students to absorb the concept. During this phase, Teacher Lim did most of the talking and at some instances, students would raise questions. Teacher responded to students' questions by giving direct answers. However, teacher did use questioning instead of providing examples directly.

Teacher Lim's explanation of FILA-MMS columns can be categorized into two categories. First, explanation based on the module and second, explanation from own understanding or using own words. Examples of Teacher Lim's verbatim for explanation directly from the module are "The Facts here is the information extracted from the problem scenario" and "Learning Issue will be things you need to know to solve the problem."

When Teacher Lim constructs explanation using own words, there are also two different outcomes: the right definition and the confusing explanation which are unable to convey the actual meaning (Figure 2). Verbatim that shows explanation constructed in own words conveying the actual meaning, such as "this is the information you can extract from the scenario here" and "symbolic means the equation" while confusing explanation are such as the explanation for micro, as shown above. This shows that the teacher failed to master and integrates between the levels.

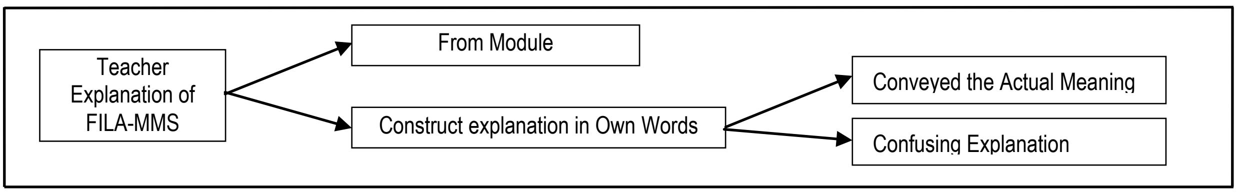

Figure 2. Categories of Teacher Explanation of FILA-MMS

Teacher Lim is new to this concept of multiple levels of representation as well as PBL, and seems to be uncertain about the FILA-MMS chart himself. After the lesson, Teacher Lim admitted that he is slightly confused about the chart too, and have yet to read through the PBL materials thoroughly and thus are not fully prepared.

4.2. Group Discussion and Group Work

The second phase is group discussion on problem analysis, learning from the given materials and filling up the FILA-MMS chart (see Appendix for problem scenario and chart sample). Teacher Lim gave students about 15 minutes to do some brainstorming and fill up the chart. A student enquired whether it's a group job. Teacher answered and instructed that everyone must write out in their chart. Another student enquired about the number of points needed. Teacher told the students to write as many points as they can, and reminded students to work in groups. Teacher also reminded students to refer to the reading materials attached in their module. From this scenario, it can be observed that the students are dependent on teacher for detailed instructions, and they would ask the teacher for instructions if not given.

Students in the same group are initially seated on the same bench in the chemistry laboratory, thus most students just started off their work without making any movements. However, a group of students moved closer together to ease their discussion while another group has been sitting near to each other since they entered the lab. Another group of only male students made fun and joked around until the teacher instructed them to start their work.

After looking through his lesson materials for a few minutes, Teacher Lim started to walk around the lab and checked on the groups. Students kept seeking for the teacher's help but the teacher wanted the students to read the reading materials attached in the module first. Throughout this phase, the teacher rotated between the groups to give guidance and opinions. From time to time, a group sought for the teacher's help by calling out for the teacher to go to their bench. All members are involved in the discussion with the teacher. They exemplified good group work and learning from group members. For other groups, students either waited the teacher to pass by or some would walk up to the teacher individually.

Different groups functioned differently. Two groups had all members working together, while students in other groups either worked individually, in pairs or in sub-groups. One of the reasons for different performances is because some students viewed this PBL lesson as unimportant and a waste of their time. Students wanted the teacher to teach exam-related topics directly. With a negative attitude, some students are reluctant to participate. The second reason might be due to the large group size. Even though literature listed the ideal number of students per group ranges from five to eight (Moust, Berkel & Schmidt, 2005; Wang, 1998) with one tutor in each group, seven students group was still too large for each and every one to participate in the discussion and to make contributions without constant teacher monitoring. Barrows (1985) suggested a group size of five for medical education. Initially, the researcher and teacher decided on five groups as there is only one teacher to facilitate all the groups. This is the restraint faced in PBL as Malaysia has large classes with only one teacher. The third reason might be because students are not used to group work and did not know how to work in a group, especially with classmates who are not so close. Two groups consist of members who know each other well. However, one group showed negative peer influence while the other showed positive peer influence. Students can both influence their peers to be off-task (chatting, playing, and singing) or to be interested and motivated on the task.

4.3. Class Discussion on FILA-MMS Chart

During this phase, students are to share their written points in the FILA-MMS chart from group discussion with other groups. Teacher started this phase by calling upon one group to share their 'facts'. Students are not used to this sort of classroom discussion and focused only on voicing out their points instead of taking turns and listening while others are sharing. The class was in a noisy state when many students tried to speak. Teacher Lim had to stop the students and instructed that they should speak one by one. Teacher Lim would call upon different groups to share their points to ensure that every group had the opportunity to present their ideas.

When Teacher Lim discussed 'facts', a student answered "Lee sensitive teeth is due to his intake of cola every day". The teacher corrected him immediately that the point should be the 'macro ideas'. This mistake might be due to the wrong concept of 'macro ideas' given by the teacher earlier on. When Teacher Lim discussed about 'macro ideas', all the points given by students are possible solutions. Again, this shows students' alternative conception that 'macro ideas' are possible solutions.

For 'micro ideas', the guiding question Teacher Lim asked is: "What are the chemicals that involve here?" Even though this question should be under 'macro ideas', it is observed that students are able to answer the teacher's question. This shows that students are able to find the information and discuss the related chemical reactions during group discussion. Students are also able to give the symbols of the chemicals involved. One student volunteered to write the chemical equation on the whiteboard. He made some mistake and his group mate walked out to the front to help out, while other members shouted out to him about his mistake. It is observed that students are learning from each other and helping their peers in their group work.

During this phase of classroom sharing, it can be observed that some students or groups would ask the teacher questions personally, and the teacher explained only to that particular student or group without sharing out with the class. This reflects previous practices where students worked individually and seeks the teacher's help personally when needed. As Teacher Lim is also used to answering students' questions directly, it did not occur to him to divert the questions to the class nor to share the topic with other students during problem-based learning.

From teacher explanation to group discussion to class discussion, the classroom learning shifted from teacher-centered to student-centered and finally to a balance between both. During the first phase, it is teacher-centered with little interactions in the class. Students started to get involved in their learning during the second phase. They discussed actively in their groups and sought for the teacher's help from time to time. During the third phase, different groups shared their points in the FILA-MMS chart. Teacher Lim gave some clarifications, explanations, and elaborations in response to the students' points and questions.

4.4. Students' Work

From the students' work (Figure 5), it can be observed that students from different groups produced a vast difference of work.

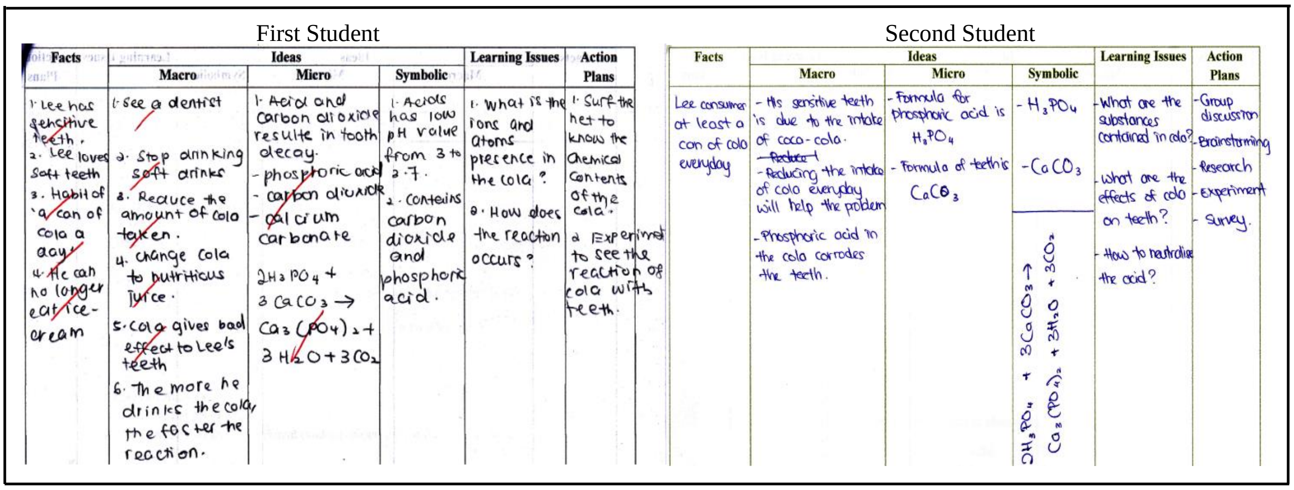

Figure 5. Examples of Students' Work

In spite of the classroom discussion and group sharing, students rarely add on additional points from other groups or edit their work during the classroom discussion phase. During after lesson discussion with the researcher, the teacher mentioned that the students are more self-centered, they only focus on completing their own tasks and do not care about others' ideas. The students' work and the teacher's description matched the classroom observation in which students only cared to list out their points but not to listen to other groups sharing.

The first student initially listed only possible solutions for the column 'macro ideas', which might be caused by the unclear explanation by Teacher Lim during introduction of the FILA-MMS chart. The final points showed that the student started to realize 'macro' encompasses more than just possible solutions. This might occur during the later phase of group discussion and during the classroom discussion phase. The second student comes from a group which has active discussion and frequently sought for teacher's guidance by calling the teacher to their group. The student's work shows that they do not possess misconception for 'macro ideas'.

The first student shows a confusion of the three columns of multiple levels of representation: macro, micro and symbolic. The ideas written in the 'symbolic' column are supposedly 'macro' ideas. However, there was no attempt shown in making corrections or indications. Secondly, chemical equations should be in 'symbolic ideas' but this student wrote under 'micro ideas'. The teacher had explicitly discussed about equations and 'symbolic' column during classroom discussion. Thus, it can be explained that the student might intently wrote the equations in the adjacent column which is broader compared to the 'symbolic' column. Therefore, for future lessons, it is recommended to use the FILA-MMS chart in the landscape orientation with broader columns.

Both students show misunderstandings for the submicroscopic level. This can be related back to the inaccurate explanation by the teacher during the first phase. Students filled up this column by answering the teacher's question: "Coke can corrode the teeth, what are the molecules that involve? What are the chemicals in the coke? That can corrode the teeth?" The teacher's unprepared state had caused students' misconception on the multiple levels of representation, which in turn caused students to continually faced confusion between levels in the subsequent lessons.

Students' work shows that different discussion occurred in different groups. It also reflects students understanding of chemistry and their behavior during class discussion. In PBL, students should also learn to be a good listener in addition to being an active speaker.

5. Conclusion and Implications:

Teacher Lim's facilitation of the FILA-MMS chart in PBL lesson is influenced by his previous teaching style. He made all explanation in one go without pausing to let students digest or check on students understanding. Students are only allowed time to think later when doing exercise or filling up FILA-MMS in PBL. He also tended to give specific instructions instead of letting students to make their own decision. When students walked up to Teacher Lim and asked questions personally, he will answer them directly in a low tone and other students are unable to benefit from it. The major difference is that he did not conduct active discussion with his students previously as he did in PBL. Secondly, students get the chance to discuss and learn from each other in PBL.

PBL using FILA-MMS chart provides an alternative method to learning chemistry. It provides a systematic way to approach problems, and also a framework to think and learn at the three levels of chemistry. Students are involved actively in their own learning and enjoyed being able to 'talk' with their peers during class time. Students faced some confusion to differentiate between the three levels of representation. The teacher plays an important role in a PBL chemistry lesson and must put enough effort to equip themselves with the related knowledge and skills, especially knowledge about the multiple representation of chemistry. The lessons and materials can be constantly improved and further implemented in other chemistry classes.

References

Abu Hassan, K. (2003). Pengajaran-Pembelajaran Kimia Di Sekolah Menengah: Ke Manakah Arah Tujunya? (Teaching and Learning Chemistry in Secondary School: Where Is It Heading?). Paper presented at the Seminar Memperkasakan Sistem Pendidikan, Puteri Pan Pasific, Johor Bahru.

Aksela, M. (2005). *Supporting Meaningful Chemistry Learning and Higher-order Thinking through Computer-Assisted Inquiry: A Design Research Approach.* Unpublished Doctoral's Dissertation. University of Helsinki, Finland.

Anuar Zaini, M. Z., Low, W. Y., Wong, Y. L., Fatimah, H., Lim, C. T., & Daniel, E. G. S. (2003). Factors Associated with Child Growth and School Performance Amongst Primary School Children. Paper presented at the CEDER Seminar, Asia-Europe Institute, University of Malaya.

Albanese, M. A., & Mitchell, S. (1993). Problem-Based Learning: A Review of Literature on Its Outcomes and Implementation Issues. *Academic Medicine*, 68(1), 52-81.

Barrows, H. S. (1985). *How to Design a Problem-Based Curriculum for the Preclinical Years*. New York: Springer Publishing Company.

Berhannudin M. Salleh, Hussain Othman, Ahmad Esa, Abdullah Federal Territory Education Department, & Hasyamudin Othman. (2007). *Adopting Problem-based Learning in the Teaching of Engineering Undergraduates: A Malaysian Experience*. Paper presented at the International Conference on Engineering Education, ICEE 2007, Coimbra, Portugal, 3-7 September.

Bilgin, I., Senocak, E., & Sözbilir, M. (2009). The Effects of Problem-Based Learning Instruction on University Students' Performance of Conceptual and Quantitative Problems in Gas Concepts. *Eurasia Journal of Mathematics, Science & Technology Education, 5*(2), 153-164.

Central Intelligence Agency (2011). *The World Factbook*. Retrieved May 11, 2012, from https://www.cia.gov/library/publications/the-world-factbook/index.html

Chandrasegaran, A., Treagust, D., & Mocerino, M. (2007). The Development of A Two-Tier Multiple-Choice Diagnostic Instrument for Evaluating Secondary School Students' Ability to Describe and Explain Chemical Reactions Using Multiple Levels of Representation. *Chemistry Education Research and Practice, 8*(3), 293-307.

Cracolice, M. S., Deming, J. C., & Ehlert, B. (2008). Concept Learning Versus Problem Solving: A Cognitive Difference. *Journal of Chemical Education, 85*(6), 873.

Devetak, I., Urbančič, M., Grm, K. S. W., Krnel, D., & Glažar, S. A. (2004). Submicroscopic Representations as a Tool for Evaluating Students' Chemical Conceptions. *Acta Chimica Slovenica*, 51, 799–814.

Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis. *Learning and Instruction, 13*(5), 533-568.

Gabel, D. (1999). Improving Teaching and Learning Through Chemistry Education Research: A Look to the Future. *Journal of Chemical education, 76*(4), 548.

Gilbert, J. K., & Treagust, D. (2009). *Multiple Representations in Chemical Education*. Berlin: Springer Verlag.

Mocerino, M., Chandrasegaran, A. L., & Treagust, D. F. (2009). Emphasizing Multiple Levels of Representation To Enhance Students' Understandings of the Changes Occurring during Chemical Reactions. *Journal of Chemical Education,* 86(12), 1433.

Gkitzia, V., Salta, K., & Tzougraki, C. (2011). Development and Application of Suitable Criteria for the Evaluation of Chemical Representations in School Textbooks. *Chemistry Education Research and Practice, 12*(1), 5-14.

Hinton, M. E., & Nakhleh, M. B. (1999). Students' Microscopic, Macroscopic, and Symbolic Representations of Chemical Reactions. *The Chemical Educator, 4*(5), 158-167. doi: 10.1007/s00897990325a

Hmelo-Silver, C. (2004). Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review, 16*(3), 235-266.

Hussain Othman, & Berhannudin M. Salleh. (2009). *First Year Students First Year PBL Experience in a Large Class*. Paper presented at the International PBL Symposium 2009, Republic Polytechnic, Singapore, 10 - 12 June 2009.

Johnstone, A. H. (1991). Why is Science Difficult to Learn? Things are Seldom What They Seem. *Journal of Computer Assisted Learning, 7*(2), 75-83. doi: 10.1111/j.1365-2729.1991.tb00230.x

Kern, A. L., Wood, N. B., Roehrig, G. H., & Nyachwaya, J. (2010). A Qualitative Report of the Ways High School Chemistry Students Attempt to Represent a Chemical Reaction at the Atomic/Molecular Level. *Chemistry Education Research and Practice, 11*(3), 165-172.

Khairiyah Mohd Yusof, Syed Ahmad Helmi Syed Hassan, & Zaidatun Tasir. (2009). *Inducting First Year Engineering Students into Problem-Based Learning*. Paper presented at the International PBL Symposium 2009, Republic Polytechnic, Singapore, 10 - 12 June 2009.

Lim, C. S., Fatimah, S., & Tan, S. K. (2002). Cultural influences in teaching and learning of mathematics: Methodological challenges and constraints. In D. Edge & B. H. Yeap (Eds.), Proceedings of Second East Asia Regional Conference on Mathematics Education and Ninth Southeast Asian Conference on Mathematics Education (Vol. 1, pp. 138-149).

Lim, T. C. (2007). Hubungan Antara Pendekatan Pengajaran Guru Dengan Pendekatan Pembelajaran Pelajar Mata Pelajaran Kimia Tingkatan Empat (The Relationship Between Teachers' Instructional Approach and Students' Learning Approach of Form Four Chemistry Subject). Master Degree, Universiti Teknologi Malaysia, Johor Bahru, Malaysia.

Moust, J.H., Berkel, H.J. & Schmidt, H.G. 2005, Signs of Erosion: Reflections on Three Decades of Problem-based Learning at Maastricht University, Higher Education, vol. 50, no. 4, pp. 665-683.

Newman, M. (2003). A Pilot Systematic Review and Meta-Analysis on the Effectiveness of Problem-Based Learning. Newcastle, UK: Learning & Teaching Subject Network for Medicine, Dentistry and Veterinary Medicine, Middlesex University.

Norman, G. R., & Schmidt, H. G. (1992). The Psychological Basis of Problem-Based Learning: A Review of the Evidence. *Academic Medicine, 67*(9), 557-565.

Schwab, K. (Ed.) (2011). *The Global Competitiveness Report 2011–2012.* Switzerland: World Economic Forum, Centre for Global Competitiveness and Performance. Retrieved September 12, 2011, from http://www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf

Sharifah Maimunah, S. Z. (2000). Current Trends and Main Concerns as Regards Science Curriculum Development and Implementation in Selected States in Asia: Malaysia. Paper presented at the International Workshop on the Reform in the Teaching of Science and Technology at Primary and Secondary Level in Asia: Comparative References to Europe, Beijing.

Tan, Y. P., & Mohammad Yusof Arshad. (2011). *Problem-Based Learning: Implementation Issues In Malaysia Secondary Schools Science Classroom*. Paper presented at the International Conference on Science & Mathematics Education (CoSMEd) 2011, SEAMEO RECSAM, Penang, Malaysia, 15-17 November 2011.

Treagust, D., Chittleborough, G., & Mamiala, T. (2003). The Role of Submicroscopic and Symbolic Representations in Chemical Explanations. *International Journal of Science Education, 25*(11), 1353 - 1368.
Vernon, D. T., & Blake, R. L. (1993). Does Problem-Based Learning Work? A Meta-Analysis of Evaluative Research. *Academic Medicine, 68*(7), 550-563.
Wang, H. A., Thompson, P., & Shuler, C. (1998). Essential components of problem-based learning for the K-12 Inquiry Science Instruction. Article submitted to the California science teacher association journal.

Appendix

Problem Scenario:

Lee loves soft drinks. A can of cola is the least he took every day. As days passed by, Lee found that his teeth have become sensitive to the extent that even eating ice-cream is an unbearable pain to him. You and your group are to help Lee understand what is happening to his teeth and advise him on his habit of "a can of cola a day".

Sample Answers for FILA-MMS Chart:

FILA-MMS Chart

Facts	Ideas			Learning Issues	Action Plans
	Macro	Micro	Symbolic		
- Lee drinks coke every day. - He has sensitive teeth. - We need to find out the cause. We need to advise him on his habit.	- Sensitive tooth due to coke. - Coke consist acid. - Acid erode tooth. - Coke consist sugar. Bacteria react on sugar and produce acid. Possible solution: - Drink coke only once a week. - Substitute with other soft drinks/ fruit juice. - Drink water only, avoid drinks with sugar. - Still drink coke, but use straw/ brush teeth more frequently/ use good toothpaste.			- What is the component of coke? - How to determine whether a drink is acidic? - What type of acid is in coke? - What is the reaction between acid and teeth? What are other factors that cause toothache?	- Find information and read articles regarding toothache and soft drinks. - Ask dentist opinion. - Carry out experiment to determine the presence of acid in soft drink/ acidity of soft drink. - Carry out experiment to see the reaction of soft drink on teeth (eggshells) and/or treated teeth (treated eggshells) -
	- Coke consists of phosphoric acid. Phosphoric acid reacts with teeth, which consist of calcium carbonate. It is a reaction of acid and metal carbonate.	2 molecules of phosphoric acid react with 3 molecules of calcium carbonate.	$2H_3PO_4 + 3CaCO_3 \longrightarrow Ca_3(PO_4)_2 + 3CO_2 + 3H_2O$	What type of acid is phosphoric acid?	
	- Phosphoric acid is a weak acid. That is why it can be the ingredients in coke in low concentration. pH of coke is below 7, but not too acidic to cause corrosion.	Only few H_3PO_4 molecules ionize while others remain as molecules. Concentration of H^+ ions is low compared to strong acids.	$H_3PO_4 \leftrightarrow H^+ + PO_4^{3-}$		

Designing "Theory of Machines and Mechanisms" course on Project Based Learning approach

Vikas V Shinde[a]*

[a]*PhD Fellow, Aalborg Univsrsity,Department of Development and Planning,Denmark*

Abstract

Theory of Machines and Mechanisms course is one of the essential courses of Mechanical Engineering undergraduate curriculum practiced at Indian Institute. Previously, this course was taught by traditional instruction based pedagogy. In order to achieve profession specific skills demanded by the industry and the learning outcomes specified by the National Board of Accreditation (NBA), India; this course is restructured on Project Based Learning approach. A mini project is designed to suit course objectives. An objective of this paper is to discuss the rationale of this course design and the process followed to design a project which meets diverse objectives.

Keywords: Theory of Machines and Mechanisms, project based learning, profession specific skills, learning outcomes

1. Introduction

There is a huge requirement of skilled engineers across the world. Internationally there is a trend moving towards outcome based engineering education. New accreditation models focus on outcome based learning. The national academies and many governments call for change in engineering education (National Academy, 2004; Royal Academy, 2007; Litzinger et al 2011). Engineering Education (EE) responds with detailed curriculum change taking place by changing the instructional methods and integrating entrepreneurial and innovation competences. In India, an engineering education is under pressure as professional engineering bodies and Indian industries call for additional set of skills and competencies such as professional, soft and personal skills (Blom and Saeki, 2009, Goel, 2006). To meet the demand of skilled engineers, the capacity of engineering educational institutions in India were increased by increasing the capacity of existing colleges and by establishing new colleges. It has resulted in an increase in the volume, but the quality of the graduate engineer is still uncertain (Rao, 2006). In most of the engineering education in India traditional instruction based pedagogy is followed and resources are available to support instruction based pedagogy. It has been observed that students focus on grades and motivation towards learning is reduced. Recent surveys conducted by National Association of Software and Services Companies (NASSCOM, 2005) and World Bank (Blom and Saeki, 2009) reported that the Indian engineers lack critical employable skills, and there is a difference between industry expectations and graduate engineering skills. These surveys reported that, the educational settings offered in India are not conducive for development of skills. Furthermore, various government reports indicated the genuine concern about the quality of an engineering education pointing towards the need for radical changes in the curriculum and the teaching-learning practices in India (NKC, 2010, Yashpal, 2010).

Given this situation, Project Based Learning (PBL) is considered as relevant (Shinde, 2011c) and suitable alternative as the past results shown that if properly designed and implemented PBL leads to the development of industry relevant skills and prepare students for life long learning (Du and Kolmos, 2006, Shinde and Kolmos, 2011b). Problem Based Learning has originated in McMaster University Canada in 1968. Later in Denmark at Aalborg, 1972 and Roskilde, 1974 two PBL models emerged. These models are designed from scratch (Graaff and Kolmos, 2003). Also, culture in these countries is different from India. Indian education systems are built for traditional teaching i.e. instruction based pedagogy. Also, teachers and students are used to traditional methods of teaching and assessment. Hence, it is necessary to develop PBL model suitable for Indian conditions. Also, challenge is to achieve learning outcomes and skills demanded by the industries. The objective of this paper is to look at different parameters considered for the design of Course Level PBL (CLPBL) model. The project design is very critical part of PBL model. The focus of this paper is to discuss development process of a project.

2. Methodology

Design based Research (DBR) methodology allows to innovate, design and modify instructional practice. At the same time DBR encourage research embedded in practice. Designing new and improved practice is a goal of DBR. The DBR phases typically include previous research and contextual understanding, design formulation or intervention design, implementation and

* Corresponding Author: Vikas V Shinde. Tel.: +91-9762051751
E-mail address: vikas@plan.aau.dk

reflection on design leading to further refinement (Cobb et al 2003). Table 1 shows DBR phases and a framework followed for this research. In this paper, we have limited our discussion within 'preparation phase' till the development of theoretical design.

Table 1. phases in DBR and Research framework

Phases in DBR	Sub phases	Major Activities in the Phases	Outcome
Preparation Phase	Prior research	PBL learning principles and learning theories. Review of PBL models and related literature. Case study on Aalborg Model Literature review on Skill and competence for engineers	Understanding And Knowledge Of Pbl Philosophy And Practice
	Contextual understanding	Identifying National and local requirements Identifying drivers and challenges Pilot work in India to understand issues and curriculum practices.	Understanding And Knowledge Of local and national level requirements, drivers and challenges
	Design formulation	Theoretical Course Design	Design ready for implementation
	Implementation Plan	Theoretical plan of implementation or Plan of learning trajectory	Plan of implementation
Design Enactment	Implementation	Design refinement in cycles and simultaneously Data collection to supplement research	Refined design and research data
Design validation	Data analysis and Reflection	Analysis for effectiveness of the design and effect of PBL implementation on students' learning outcomes.	Effectiveness of the design and outcome of research
	Reflection (Re-Design)	Reflection on data and defining prerequisites for the improvement in the original design to implement in a next cycle	Perspectives and recommendations for new designs

2.1 Contextual Understanding- Indian Requirements

As discussed above, it is most important to understand the context in which model is to be implemented. We have carried out literature review to understand the current requirements of Indian engineering education. We found important publications related to Indian system which set the objectives of the design. Also, we visited the institution at which PBL is to be implemented. We read curricular documents and understood its requirements. Also, interaction with the administrators, students and teachers has given us critical insight in the educational environment and procedure followed in the institute. An outcome of these two interactions is discussed below.

2.1.1 Need of the Design

2.1.1.1 Profession specific skills from surveys

In 2005, the NASSCOM and McKinsey came with the report that, only 25% of the engineering education graduates are employable by a multinational company (NASSCOM, 2005). Most of the surveyed employers linked this condition to the shortcomings from the education system. In the same year, the Planning Commission, Government of India came with the recommendations to focus on enhancing the quality of educational institutions and a priority for proper arrangement for the development of skills (p-13) at these institutions. Accordingly, a National Knowledge Commission (NKC, 2008) on higher education was constituted in June, 2005. The purpose is to prepare a draft for reconstruction of India's knowledge related infrastructure. The NKC submitted its recommendations to the Government in 2008. Following this report, the Ministry of Human Resource Development (MHRD), higher education department constituted a committee under the chairmanship of Prof. Yashpal. It reported a serious concern in respect of growing engineering colleges by saying they have largely become, just business entities dispensing very poor quality education (p-05) and indicated that there exists a difference between learning from an institution and expectations from industries. Committee also recommended that the universities must adopt a curricular approach which treats knowledge in a holistic manner to create opportunities to bridge the gap by relating to the world outside (p-12). It hinted that Indian higher education system needs a drastic overhaul (p-54) with a proposal of curricular reforms at undergraduate programs to enable students to have opportunities to access all curricular areas and integration of skills with academic depth (p-64).

In view of these reports there was an increasing demand from teachers, administrators, and policy makers to understand the kinds of skills demanded by the employers from an engineering graduate. So, to identify skills demanded by the employers an

Employer Satisfaction Survey was carried out in 2009 (Blom and Saeki, 2009). This study was supported by Government of India, the World Bank and the Federation of Indian Chambers and Commerce Industries (FICCI). In this survey, 157 industries from India responded. According to the survey, 64 percent of surveyed employers are not satisfied with the quality of engineering graduates skills. It reported that the graduate engineer lacks in process skills such as teamwork, lifelong learning and communication skills. The graduates lack in higher-order thinking skills, such as problem-solving, conducting experiments, creativity, and application of modern tools. The survey recommended the need of improvement in the curriculum to ensure that the graduate engineers' skill is getting developed (Blom and Saeki, 2009). These requirements are considered while designing a project.

In addition to national surveys, we also studied international research (National Academy, 2004; Royal Academy, 2007). We found that skills like teamwork, problem solving, creativity and innovations along with communication skill are valued by most of the industries. This review helped us to gain knowledge about change happening in the field of engineering education. The main purpose of the CLPBL would be to provide platform for students to be trained on these industry relevant skills.

2.1.1.2 Learning outcomes specified by National Board of Accreditation (NBA)

In response to the recent developments in Higher education in India and across the world; the Ministry of Higher Education in India has decided to change the accreditation criteria to become outcome based. India, being a member of the Washington Accord, applies Accreditation Board for Engineering and Technology, [ABET] criteria 2011-12 to assess the quality of education in educational institutes. Table 2 shows a summary of the ABET criteria. Since, NBA is the apex body which ensures quality education is imparted in India, these criteria along with the survey results are critically considered for the project design.

Table 2 Summary of ABET Criteria.

Learning outcome(LO)	Statement of LO
(a)	An ability to apply knowledge of mathematics, science, and engineering
(b)	An ability to design and conduct experiments, as well as to analyse and interpret data
(c)	An ability to design a system, component, or process to meet desired needs within realistic constraints, such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d)	An ability to function in multidisciplinary teams
(e)	An ability to identify, formulate and solve engineering problems
(f)	An understanding of professional and ethical responsibility
(g)	An ability to communicate effectively
(h)	The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i)	A recognition of the need for, and an ability to engage in life-long learning
(j)	A knowledge of contemporary issues
(k)	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

2.1.2 Course level requirements

The University of Pune (UoP) is located in the Maharashtra state; the western part of India. It should be noted that the engineering institution at which PBL is to be implemented is affiliated to the (UoP). Hence it is important to understand the role of UoP. Affiliation means that the UoP will award degrees to all students educated by this institute. Also, it means that the institute has to follow the rules, regulations and the curriculum designed by the UoP. The UoP is also responsible to conduct a common written examination (final evaluation), for the affiliated institutes' students. In abstract, an institution's role is limited only for preparing students for the final evaluation. To achieve this, all institutes practice traditional instruction, lecture based strategies. In the next section the existing curriculum is discussed.

2.1.2.1 Existing curriculum requirements and procedure

In the existing curriculum, there are five courses carrying equal marks for the final theory examination (UoP, 2012). However, the PBL model is to be designed for only one course "Theory of Machines and Mechanisms" out of these five. Table 3 shows the existing course structure. The syllabus content (UoP, 2012) to be taught for above course is provided by the university. It is divided into six units which carry equal marks in the examination. The topics to be covered are listed under each unit. A list of the experiments which the students must perform during the semester is also provided in the syllabus.

Table 3 Existing Scheme

Course name	Teaching scheme		Examination scheme		Total marks
	Lecture (Hrs/week)	Practical (Hrs/week)	Theory	Term work	
Theory of Machines and Mechanisms	4	2	100	50	150

Responsibility to prepare students for final evaluation lies with the teacher. Mostly the traditional instruction based pedagogy is practiced for which the teacher has been allotted four hours per week (refer table 3). The lectures are scheduled and the timetable is displayed on a notice board. This is followed for all the courses in the curriculum. To perform experiments (Practical) students visit laboratory for two hours in a week. Generally, a class of 60–70 students is divided into three groups of equal sizes. Each group visits the laboratory (table 3) as per the timetable. At the end of the semester, each student has to write a journal which has to be certified by the subject teacher before the final term work submission.

Table 3 also provides a summary of the examination scheme for the given course provided by the university. It may be noted that the university is responsible for the final evaluation (to conduct 100 marks theory exam). Responsibility to prepare students for this final examination lies with the institute (mainly course teacher). To do that, the unit tests are designed and conducted by institute. The aim of these tests is to assess the students' knowledge, understanding gained from classroom instructions, and also to provide them timely feedback on their performance. At the end of the semester, all the students from the course have to appear in the written examination arranged and administered by UoP. This examination is based on the content of the syllabus, so, the students' goal is to score good marks and teacher's focus is to prepare students for the same.

After analysing the curriculum the following observations are made:

1. The course teacher does not have any right to change the syllabus and examination scheme, though there is a flexibility to adopt any teaching-learning strategy.
2. The students' learning takes place mainly in classrooms and laboratories.
3. In the existing evaluation scheme, the students' abilities to remember and reproduce are assessed
4. The current curriculum structure does not contain a project head and students are graded individually.

2.1.2.2 Summary of expectations from the Design

After assessing the requirements at the national and curricular levels, it can be concluded that there is an urgent need to provide an opportunity to make students active in the learning process and to provide opportunities to achieve the skills and abilities desired by the industry, and ABET criteria. It is also very important to prepare students for final evaluation. These are the main objectives of the CLPBL.

2.2. Research on PBL

2.2.1. PBL learning principles

Problem Based Learning (PBL) and Project Based Learning (PBL) terms are used interchangeable with each other. The six core characteristics of Problem Based Learning was described by Barrows (1986) are:

1. The learning needs to be student-centred.
2. The learning has to occur in small student groups under the guidance of a tutor.
3. The tutor acts as a facilitator or guide.
4. The learning starts with an authentic problem.
5. The problems encountered are used as a tool to achieve the required knowledge and the problem-solving skills necessary to eventually solve the problem.
6. Self-directed learning for acquisition of new information.

Various authors (Prince and Felder, 2006; Savin-Baden, 2000) tried to differentiate between these two. A project has a broader scope and the focus is one the end product. The completion of the project mainly requires application of previously acquired knowledge, while in Problem based learning the focus is on the acquisition of new knowledge and the solution is less significant. In other words, the importance in problem-based learning is on acquiring knowledge whereas in project- based learning is on applying it. Some similarities are also been researched; at root level both approaches share same learning principles viz. cognitive, content learning, and social (Graff and Kolmos, 2003). The both approaches share some common elements: both are student centred approach in which learning is organised around problems (Graff and Kolmos, 2007, p-6), involves teams and call for the students to formulate solution strategies and to continually re-evaluate their approach in response to outcomes of their efforts (Prince and Felder, 2006).The cognitive learning approach means that the learning is organized around the problems and will be carried out in the projects. A problem becomes central part of learning process and becomes motivation for learning. The students learn by his experiences while confronting to tasks involved in the problem solving process. A content approach especially concerns disciplinary and interdisciplinary learning. It is an exemplary practice carried out to address learning objective of the subject or curriculum. It also supports the relationship between theory and practice. The third principle emphasize on the concept of working in a team. The team or cooperative learning is a process in which learning is achieved through dialogue and communication between the team members. Students not only learn from each other, but also share the knowledge. Also, while working in a team they develop collaborative skill and critical project management skills.

To elaborate more about the projects, Graaff and Kolmos (2003) defined three types of projects as *Task project, Discipline project and Problem project* that differ in the degree of student autonomy. *Task projects* are the projects in which student teams work on projects that have been defined by the instructor, and provides minimal student motivation and skill development. In *Discipline projects* the instructor defines the subject area of the projects and specifies tasks in it. The students have autonomy to identify the specific project and decide how to complete it. In *Problem projects,* the students have practically entire autonomy to choose their project and their approach to it. They noted that the students face difficulty in transferring methods and skills acquired in one project to another project of different discipline. In this paper, the Project Based Learning approach is used.

2.2.2 Review of PBL models and related literature

Victoria University (VU), Australia introduced PBL into engineering curricula for different courses in 2006. There are many multivariate models that satisfy to what is defined to be PBL pedagogy. Implementation of PBL to engineering curriculum needs to be placed in a local context and must be developed with careful considerations of social, economic, ethnic diversity of the students and the university academic culture (Rojter, 2006). At Samford University, Birmingham also PBL has a positive impact on student learning. The need to work closely with other institutions that have incorporated PBL in their curricula to develop valid and comprehensive PBL assessment measures is felt (Eck and Mathews, 2002). To enhance engineering education by promoting and facilitating the use of PBL in engineering four British Universities undertaken a three-year project. This study shows effective and well-structured project work can improve student’s key transferable skills and their grasp of subject content. Studies have also shown that information learned by project work has over 80% retention after one year, whilst information derived from lectures has less than 20% retention after the same time period (Moore and Willmot, 2003). Awareness and the usefulness of PBL spread across the world and many Asian universities were attracted to implement PBL in their institutions. The ‘one problem per day’ model of the Republic Polytechnic (RP), Singapore (O,Grady and Alvis, 2002) is one of the popular examples from Asia in Problem Based Learning model. Apart from this, many more cases of PBL implementation in Asia can be found in the literature; China (Cheng, 2003), UTM (University Technology, Malaysia), Malaysia (Khairiyah et al. 2005), Tribhuvan University, Nepal (Joshi and Joshi, 2011), and Mae Fah Luang (MFU) Thailand (Yooyatiwong and Temdee, 2012), are a few to mention. There could be more examples; we have mentioned few of them.

It shows that PBL is disseminated and accepted by Asian countries along with the western world. These models differ in their designs, which are seldom adjusted to suit local culture, the history of education, and other local conditions. Considering Indian case, it may be noted that the PBL is neither an accepted nor an officially recognized methodology for engineering education in India. The application of the PBL approach in the teaching–learning process and its scientific investigations are very rare (Mantry et al 2008, Raghav et al, 2008, Abhonkar, Harode and Sawant, 2011). The results of these few experiments indicate that PBL implementation in India needs to be considered appropriately and that more focused, scalable efforts are needed (Mantry et al 2008). It has also been reported that lack of proper guidance, trained staff and infrastructure have hindered the growth of PBL in India (Shinde and Kolmos, 2011a). Hence, the research and training in PBL curriculum design and integration into the existing curriculum is needed to improve the acceptance of the PBL approach by Indian educators.

2.2.3 Case study on Aalborg Model

The author spent 18 months in Denmark to learn PBL philosophy and practice. To get practical insight into PBL curriculum and practice, a six months case study on Aalborg PBL model was conducted in 2010-11 (Shinde and Kolmos, 2011b) autumn semester. Following figure 1 shows Aalborg PBL model practiced for Masters Programme in Mechanical Engineering. It could be seen that 50% European Credit Transfer System (ECTS) are allotted to the courses and 50% ECTS for project in this model.

COURSE 1 5 ECTS	COURSE 2 5 ECTS	COURSE 3 5 ECTS
	PROJECT 15 ECTS	

Figure 1 Aalborg PBL model for Masters Programme in Mechanical Engineering.

Curriculum practiced at Aalborg is analysed in terms of Biggs (1996) constructive alignment, which says that to achieve educational objectives; content, teaching-learning practice and assessment should be aligned to each other. Accordingly Aalborg curricular analysis showed that learning from courses is closely aligned with learning outcomes to be achieved through projects. In other words there exists very close alignment between courses and projects. Regarding assessment, the students are assessed through project presentations, and viva-voce. It has been observed that the courses (content approach) and projects (cognitive approach) are designed to suit educational objective of the programme. Also, we have seen students working in the teams, which indicated cooperative and collaborative approach of PBL. We have found that to facilitate group work each group has been provided with a group room consisting of seating arrangement, pin-up boards, black or white board and internet connections. These gadgets are found useful for PBL practice. From this case study, we understood important aspects of PBL model design and practice.

3. Course Level PBL model (CLPBL) - Theoretical design

The first step in the design was to define the prerequisites and objectives of the project design. Accordingly, we envisioned the nature of the design and defined objectives which guided the project design.

3.1 Design prerequisites and objectives

These are as follows:

1. The design must meet the PBL principles and enable scientific investigation.
2. It must be inline with the existing academic structure and current course content leading to improved content learning.
3. It must improve and facilitate the attainment of LOs as defined by ABET and survey skills.
4. It must ensure students' continuous engagement and must not stress participants in the project activities.
5. The project should be completed within the time frame of 12 weeks and should not cause any financial burden on the participants.
6. It can be completed within the existing infrastructural facilities at the institute.

After defining objectives, the next step was to find an opportunity to embed a project work in existing academic structure. As discussed in the earlier sections, there is no possibility for change in the course content and the examination pattern. During curriculum analysis, we found the term 'term work', which means, work which needs to be carried out by the individual students in a given term. There is an element of flexibility involved in the term work. The teacher can assign any work or design activities related to the course which could be possible to accept as term work. Accordingly, we decided to embed project work within the term work. Hence, we divided the 50 marks for term work into two parts, being 25 marks for assigned laboratory activities (as per the UoP) and 25 marks for a project as shown in Table 4.

Table 4. Modified Academic Structure with Project

Course name	Teaching scheme		Examination scheme		Total marks
	Lecture (Hrs/week)	Practical (Hrs/week)	Theory exam marks	Term work marks	
Theory of Machines and Mechanisms	4	2	100	25	125
Project Work	-	-	-	25	25
Total	4	2	100	50	150

The following change has been made in the current curricular settings to evolve the new design.

1. Course objectives were defined.
2. The team based project activity is adjusted in the existing curricular scheme
3. Field work for each team was made mandatory.
4. Technical report writing is added to improve technical writing skills.
5. An end-of-term presentation is added to improve communication skills.
6. Assessment norms are designed and group evaluation is added.

3.2 Project design – Characteristics of Model and Project

The course approach is typically used in the traditional system where there are parallel courses. The lecturer decides on the specific learning objectives, teaching and learning methods. This means that students participate in mix of traditional and PBL course (Graff, Kolmos and Du, 2009). In our design course approach is followed pertaining to various challenges and constraint associated to system level implementation. As can be seen from the figure 2, the highlighted portion shows the course in which PBL is implemented whereas other courses are taught by traditional instruction based strategy. Savin-Baden and Major (2004) defined different curriculum modes in problem based learning in which they explained eight modes. Mode 1 is characterized when PBL is applied in a one module and Mode 2 is characterized by module run by teacher interested in implementing PBL and other teachers are not interested. In our case, PBL is to be implemented in one of the course of the curriculum (Mode-I) and implemented by a single interested teacher in his class (Mode-2). Hence, we concluded that our design could be in between with Mode 1and 2.

Courses	Teaching Learning Strategy	Students activities	Assessment
Course-1	Classroom Teaching	Individual Reading and Writing	Individual Assessment
Course-2	Classroom Teaching	Individual Reading and Writing	Individual Assessment
Course-3	Classroom Teaching	Individual Reading and Writing	Individual Assessment
Course-4	Classroom Teaching	Individual Reading and Writing	Individual Assessment
Course-5 Theory Of Machines And Mechanisms	**Classroom Teaching and Project Based Learning**	**Team working on Project-collaborative learning, researching and writing**	**Assessment in Team and Individual grading**

Figure 2. Course level PBL model

Experience gained through the case study conducted at Aalborg University (Shinde and Kolmos, 2011b), a review on PBL models (Graaff, Kolmos, and Du, 2009, Cheng Charles, 2003) and the Content, Context, Connection, and Researching, Reasoning Reflecting (3C3R) model of problem design (Hung, 2009) guided the process of project design. We designed the project activity in such a way that we could cover course objectives or the syllabi of existing courses and graduate LOs. The project activities are designed and adjusted to suit institutes' existing academic culture and infrastructure. We finalized a problem statement and developed a series of project activities as shown in table 5.

Table 5. the Major Activities in the Project

Problem statement	**Analyse any real life engineering mechanism (case) to evaluate its degree of Freedom (DOF).**
Defined project activities	Form the team. Identify, submit and justify the case. Text book problem solving in a group. Laboratory work in a group Undertake field work. Explain the working of the mechanism. Find types of links, pairs and joints used in the mechanism. Classify, specify and calculate them. Apply Grubler's criteria. Find the DOF and justify your answer. Draw kinematic diagram Find and locate types of Instantaneous centre of rotation Calculate velocity and accelerations of each link. Prepare a technical report. Present to an audience. Questions and answers.

As per the Savin-Baden (2000), given model could be characterized by Model I and II. Model –I is characterized by a view of knowledge that is essentially propositional with students are expected to become competent in applying knowledge in the context of solving and managing the project. In Model II, an emphasis is on actions which enable students to become competent in practice. In designed model, students are applying propositional knowledge and doing many activities to ensure they become competent in engineering practice. The given project can be characterized as Task-Discipline project (Graff and Kolmos, 2003). The project tasks (table 5) are predefined by teacher to suit curricular (course) objectives pertaining to specific discipline. Students' role is to perform the project tasks given by the teacher. There is amount of autonomy given to the students to choose any mechanism according to their interest. This will provide them intrinsic motivation. Also, they decide their team and set up their project plan for the entire semester. Also, acquiring additional information for getting the desired output is decided by them. The table 6 shows, a coherence of project activities, learning outcomes and skills demanded by the industry. It shows that after implementation above design will ensure achievement of desired objective of achievement of skill. For example, undertaking the fieldwork with team will ensure application, acquisition and construction of knowledge along with understanding relation between theory and practice.

Table 6. Mapping of the project activities, targeted learning outcomes and skills

Project activities	Target Learning Outcome (LO)	Target skills from survey
Form the team.	d	Negotiation, Teamwork
Identify, Submit and justify the case.	a,i	Knowledge, reading, willingness to learn
Laboratory work in a group.	b,d,i,	Teamwork, reading, conduct experiments/data analysis
Text book problem solving in a group	d,e,a	Teamwork, problem solving, knowledge
Undertake the field work.	a,k,i	Knowledge, theory and practice, willingness to learn
Explain the working of the mechanism.	a	knowledge
Find types of links, pairs and joints used in the mechanism.	a	Application of knowledge
Classify, specify and calculate them.	a	Application of knowledge
Apply Grubler’s criteria.	a	Application of knowledge, technical skill
Find the DOF and justify your answer.	a	Application of knowledge
Draw kinematic diagram	a	Application of knowledge
Find and locate types of Instantaneous centre of rotation	a	Application of knowledge
Calculate velocity and accelerations of each link.	a	Application of knowledge
Prepare a technical report.	g,k	Written communication, Modern tools
Present to an audience.	g,k	Verbal communication or presentation skills, Modern tools.
Questions and answers	g	Communication in English

3.3 Assessment and evaluation criteria for project work

The project work undertaken by the students needs to be assessed and evaluated. Accordingly, we designed an assessment and evaluation scheme for 25 marks as shown in table 7.

Table 7. Assessment and Evaluation Scheme for a Project Activity

Assessment marks			Evaluation marks		Total marks
Teamwork	**Feedback**	**Attendance in all sessions**	**Quality of technical report**	**Presentation and question answer session**	
5	5	5	5	5	25

Teamwork is assessed through observations and feedback from team members on a five-point scale. Feedback in the assessment norm means the completion and timely submission of questionnaires, essays and informal discussions. Attendance in all sessions means attendance during feedback sessions, presentations and interaction sessions. The quality of the technical report is assessed for the technical content, plagiarism and adherence to the given format. Five marks are allotted for students’ performances in a presentation and a question-answer session. Finally, the marks for all the sub-headings are summed to grade the individual students’ project work out of 25. It may be observed that students in new academic settings are assessed to a group and graded individually. Hence, a course in Mechanical Engineering was designed based on the PBL approach. This design meets the criteria mentioned in Section 2.

4. Experiences during implementation and reflection

Historically, in most of the academic institution in India instruction based pedagogy is practiced and institutes are built to support it. Designing PBL course was a challenging task. Since, we knew the system constraints well in advance, hence contextual understanding helped enormously while designing CLPBL model. For design purpose many challenges (Shinde and Kolmos, 2011a)) like motivation for change, lack of resources, curricular and students’ preparedness are considered. Understanding derived from case study at Aalborg University, Denmark and a literature review of PBL models, influenced our model. While designing we have mainly included course objectives, skills from the survey and learning outcomes defined by NBA.

So, far we have implemented this design in two semesters. The data collected was analyzed to interpret effectiveness of design. The results from these experiments indicated encouraging results with the students and staff accepting the course designed on PBL approach. We understood that given design encompasses 50% of course content, which ensured students are prepared for evaluation. This aspect was very important for students' motivation. In the last semester results for this course increased to 87% from 64% which partly can be attributed to our design. Also, it helped engineering graduate for promotion to acquire 13 skills demanded by the industry and seven learning outcome defined by NBA. Further, research is required to assess learning outcome and skill achievement. This design so far influenced 249 students of the second year mechanical engineering students and could be a representation to design PBL courses in other courses in the Institute.

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References

ABET 2012, Accreditation Board for Engineering and Technology, *http://www.abet.org/uploadedFiles/Accreditation/Accreditation_Process/Accreditation_Documents/Current/abet-eac-criteria-2011-2012.pdf,* Assessed 10th Dec 2012

Abhonkar P., Harode A., and Sawant N. (2011), Effect of Projects on Learning: An Indian Case Study, *PBL across the disciplines: research into best practice, 3rd International Research Symposium on PBL 2011, Coventry University, U.K*, 28–29 November2011, 489–501.

Barrows, H.S.(1986), a taxonomy of *Problem based learning methods, medical education, 20, 481-486.*

Biggs J. (1996), Enhancing teaching through constructive alignment**,** *Higher Education*, **32:**, pp-347-364,

Blom A, and H. Saeki (2009), Employability and Skill Set of Newly Graduated Engineers in India, *Bank Policy Research Working Paper Series, Volume 11.*

Cheng Charles (2003), Introducing Student-centered Teaching Strategies to Improve Teaching and Learning, in Theory of Machines and Mechanism, *the China papers*, July 2003, pp. 5–9.

Cobb, P., Confrey, J. diSessa, A., Lehrer, R. and Schauble, L. (2003). Design Experiments in Educational Research. Educational Researcher. 32(1) 9-13, downloaded on 17/11/2011, at Aalborg University, Denmark.

Du X. Y., and Kolmos A. (2006), Process Competencies in a Problem and Project Based Learning Environment, *35th SEFI Annual Conference: Engineering Education and Active Students*, Uppsala, Sweden, 2006.

Eck J C., Mathews D G. (2002) "A Sample of Assessment Findings Related to Samford University's PBL Initiative.

Goel ,S (2006), *Investigations on required core competencies for engineering graduates with reference to the Indian IT industry*, European Journal of Engineering Education, 31:5, 607-617.

Graaff E. D., and Kolmos A (2003)., Characteristics of Problem-Based Learning, *Int. J. Eng. Ed*. Vol. **19**, No. 5, pp. 657–662.

Graaff E D, Kolmos, A.(2007) "*Management Of Change ;implementation of problem and project based learning in engineering*", sense publishers, pp-1-8.

Graaff E D, Kolmos, A. Du, X, (2009) "*Diversity of PBL; PBL learning principles and models*" *Research on PBL practices in engineering education*, sense publishers, pp-9-21.

Hung W. (2009), the 9-step problem design process for problem based learning: application of 3C3R model, *Educational research review***, 4,** pp-118-141.

Josef Rojter, PBL as means to better engineering education? Victoria University, Melbourne City, Australia.Graaff E. D., and Kolmos A (2003)., Characteristics of Problem-Based Learning, *Int. J. Eng. Ed*. Vol. **19**, No. 5, 2003, pp. 657–662.

Joshi R.K., and Joshi M. (2011), Problem Based Learning in Engineering at the Institute of Engineering: Prospects cum Challenges, *Journal of the Institute of Engineering*, 8.1-2, 2011, pp-291-300.

Khairiyah M. Y., and M.K.A. Hamid, A. Hassan, M. Ariffin, M. H. Hassim, S. Hassan, S.A. Helmi, and Z. T. Khairiyah (2005), Outcomes of PBL Implementation from Students' Perspectives, *Proceedings of the Regional Conference on Engineering Education*, Johor, Malaysia, December 12–13, 2005.

Litzinger, T.A., Lattuca, L.R., Hadgraft, R.G.& Newstetter, W.C. (2011).*Engineering Education And The Development Of Expertise - Journal Of Engineering Education* (pp. 123-150).100 (1).

Mantri A., Dutt S., Gupta J., and Chitkara M. (2008), Design &Evaluation of PBL-based Course in Analog Electronics, *IEEE Transactions on Education*, Vol. **51**, N. 4, November 2008, pp. 432–438.

Moore A. and Willmot P. (*2003)*, PBLE-Guidelines for PBL in Engineering, *Proceedings of the International Conference on Engineering Education, 2003,* University of Nottingham,

NKC, 2010, Knowledge Commission, Report to the Nation, 2006–2009, http://www.knowledgecommission.gov.in/downloads/report2009/eng/report09.pdf, Assessed 10th August 2012

National Academy of Engineering. (2004). *The engineer of 2020 - Visions of engineering in the new century.* National Academies Press.

Nasscom,2005, McKinsey Report http://www.mckinsey.com/locations/india/mckinseyonindia/pdf/nasscom_mckinsey_report_2005.pdf

O'Grady, and G. Alvis, W.A.M (2002), One Day One Problem: PBL at Republic Polytechnic, *4th Asia-Pacific Conference On PBL*, Hatyai, Thailand, December 2002.

Prince M, Felder R., Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases, *Journal of Engineering Education*, April 2006,pp-123-138

Raghav M. S., Jain S. and Saha S.K. (2008), Robotic Competition Based Education in Engineering (RoC-BEE), *Proceedings of NCMSTA'08 Conference National Conference on Mechanism Science and Technology: from Theory to Application National Institute of Technology, Hamirpur*, 13–14 November 2008, pp-1-11.

Rao (2006), Rao Committee Report, Faculty Development in India, July2006.

Royal academy of engineering, (2007).*Educating Engineers For 21st Century*, Retrieved March 29, 2012, from http://www.raeng.org.uk/news/release/pdf/Educating_Engineers.pdf

Savin-Baden,M. (2000), Problem Based Learning In Higher Education: Untold Stories, Society For Research Into Higher Education and Open University Press.

Savin-Baden,M.and Major, C (2004), Foundations Of Problem Based Learning, Maidenhead, Open University Press/SRHE.

Shinde,V. and Kolmos A., (2011a) PBL In Engineering Education: Drivers And Challenges, *Proceeding of International Conference WVITAE2011*, 28 Feb – 3 Mar 2011, p. 42.

Shinde V., and A. Kolmos (2011b), Students Experiences in Aalborg PBL Model: A Case Study, *SEFI Annual Conference, Lisbon*, 27–30September 2011.

Shinde V. (2011c), Relevance of the Problem and Project Based Learning (PBL) to the Indian Engineering Education, *across the disciplines: research into best practice, 3rd International Research Symposium on PBL, Coventry University, U.K*, 28–29 November2011, 489–501.

UoP, (2012), University of Pune, http://www.unipune.ac.in, assessed 12th Nov 2012.

Yashpal (2010), Yashpal Committee, Report of The Committee to Advise on Renovation and Rejuvenation of Higher Education, http://www.hindu.com/nic/yashpalcommitteereport.pdf, Assessed 23rd Sept 2011.

Yooyatiwong Thongchai and Punnarumol Temdee, (2012) IT-PBL model and implementation framework for Mae Fae Lung University, case study: school of information technology, *1st international conference on "Mobility for Life: Technology, telecommunication and PBL",* Mae Fae Lung University Chiang Rai, Thailand, 5-7th March 2012, p-61.

Defining Vocational Education and Training for Tertiary Level Education: Where does Problem Based Learning Fit in? – A Literature Review

Ismail N.b [a] *

[a]*Norhariati binti Ismail, Aston University, Birmingham and B4 7ET, United Kingdom*

Abstract

The purpose of this paper is to review the merit of Problem-Based Learning as a learning and teaching strategy for Vocational Education and Training institutions. The literature review presents a fresh perspective of Vocational Education and Training system and argues the effectiveness of its application in this 21st century education system. This article then compares a few active learning approaches such as Problem-Based Learning, Project-Based Learning and CDIO (Conceive-Design-Implement-Operate) which are commonly used in the engineering discipline. Then paper concludes with the findings and states the role of Problem-Based Learning in Vocational Education and Training context.

Keywords: Vocational education and training, problem base learning, active learning, tertiary level, engineering;

1. Introduction

The learning and education approaches have developed significantly from traditional method or teacher cantered learning. Teacher centered learning is content driven with educators focusing on course objectives (Ariffin et al., 2004). In teacher centered learning, educators normally will present, interact, discuss, demonstrate and communicate with students face to face (Azizan, 2010). As for engineering program, the approaches are mainly by lectures supplemented with tutorials (numerical problem solving) and practical (laboratory) classes. A similar approach is delivered for Vocational Education and Training where students normally start with describe, demonstrate, try-out by trainee and evaluate with feedback.

With the rapid change of technology and world globalization, it is essential to prepare students as they are the future workforce. The term '21st century Skills' refers to skills that are required for employability (Dede, 2010). Thus, it is necessary to look back on our educational approach and pedagogy in order to accommodate the student to be an effective worker. An Active Learning approach which is centered around the student can encourage deep learning and also improve student's competencies such as critical thinking, problem solving and creativity, communication skills as well as collaborative skills (Adams, Kaczmarczyk, Picton, & Demian, 2011; Nepal & Jenkins, 2011; Rojter).

The aim of this paper is to investigate the application of the Problem-Based Learning approach in Vocational Education and Training, particularly for tertiary level education. In addition to that, the discussion of this paper is only focusing on the engineering discipline. Starting with a background of Vocational Education and Training, this paper also reviews and compares other active learning approaches that are commonly used in the engineering discipline, which can also be used in Vocational Education and Training.

2. Background – Context: Vocational Education and Training and Active Learning

2.1. Vocational Education and Training

Vocational Education & Training is recognised globally as an effective learning method, which can contribute to economic growth (MacDonald, Nink, & Duggan, 2010). It is one of the terms in the education system that deals with practical hands-on experience, which is always related to the working environment. This education approach is different to the general academic education system, which builds analytical skills, theories and critical thinking whereas in vocational education, training is based on the job skills which are required in a specific area (Nilsson, 2010). Despite being label as 'second class' education compared to academic education system, the Vocational Education and Training policy that emphasizes on skills generates different perception on how it can benefit from the way the Vocational Education and Training is embedded in institutional context (Eyre, 2011). In addition to that, Eichhorst, Rodriguez Planas, Schmidl, and Zimmermann (2013) believed that "Vocational Education and Training gives an opportunity for young people who lack resources, skills or motivation to pursue their education to a higher level"(p. 1).

The acceptance and implementation of Vocational Education and Training varies throughout the world. In most countries, Vocational Education and Training is quite separate from the formal education system. Chappell (2003) indicates that the

* Corresponding Author name. Tel.: +44-121-204-3502
E-mail address: ismailnb@aston.co.uk

reformation of the Vocational Education and Training system is due to the need for the education and training systems to be more aligned with the contemporary requirements of the economy(p. 22). MacDonald et al. (2010) added that "in Asia countries like Malaysia, Singapore and South Korea are focusing on 'Human Resource and Workforce Development' as the result of Vocational Education and Training where all entities, private, public and social contribute to the training and employment in the vocational education system"(p. 6). On the other hand, a country like German implements a dual system where higher education and Vocational Education and Training are structured together in order to embrace national qualification as well as the training requirements (Eichhorst et al., 2013). Regardless the implementation across nations, the primary advantage of vocational and technical education is to provide a skilled worker as per the market requirements. In context of the application to the engineering discipline, this will provide a skilful workforce that deals directly with industry and manufacturing sector.

Apart from that, United Nations Educational, Scientific and Cultural or UNESCO (2002) defines "Technical and Vocational Education as a comprehensive term referring to those aspects of the educational process involved, in addition to general education:

- the study of technologies and related sciences;
- the acquisition of practical skills, attitudes, understanding, knowledge relating to occupations in various sectors of economic and social life" (p. 7).

Though Vocational Education and Training manages to fulfil the aim of producing students with competencies in technical skill, Leung and McGrath (2010) stress that students lack employability skills. To support that, many studies had revealed that engineering graduates need more than technical knowledge in order to accommodate current employment requirements (Nair, Patil, & Mertova, 2009; Selvadurai, Choy, & Maros, 2012; Zaharim et al., 2010). In the current global working environment, additional skills are required in the areas of communication, collaboration and problem solving. The shortage of interpersonal skills amongst engineering graduates, particularly for Vocational Education and Training has given an alarming sign to improve the learning system (Leung & McGrath, 2010). Apparently, in Vocational Education and Training, the learning and teaching methods are normally delivered the traditional way, which is the 'four steps method', introduced by Allen (1919). This one way of learning has been used for a long time where students accept knowledge from the tutor without knowing the importance of why they doing it (Salleh, Othman, Esa, Sulaiman, & Othman, 2007).

Hence, the idea of 'active learning' has triggered the educators in order to replace this traditional method. An active learning approach is well accepted in the 21st century with many forms of active learning in place such as Problem-Based Learning, Project-Based Learning, CDIO, Inquire-Based Learning, and many more (Leung & McGrath, 2010; M. Prince, 2004; Michael Prince & Felder, 2007). All these new approaches have the same aim, which is to produce students with multiple competencies as well as to encourage lifelong learning. Despite many advantages, M. Prince (2004) revealed that some faculty are still sceptical in adopting active learning as their new teaching and learning approach . Therefore, it is crucial to understand each concept and approach in order to avoid misconception and fail to reach the aim.

2.2. *Active Learning*

2.2.1. Definition of Active Learning

Active learning is defined as instructional activities that require students in doing things and also think about what are they doing (Bonwell & Eison, 1991) This is different to traditional lecture methods, in which professors talk and students listen (Bonwell & Eison, 1991; M. Prince, 2004). Chickering, Gamson, and Poulsen (1987) added that in active learning, "students must do more than just listen" while M. Prince (2004) mentioned that active learning is a term normally used to relate "any suitable methods that engages student in the learning process" (p. 1). However, M. Prince (2004) also highlighted some confusion of Active Learning approaches in traditional taught engineering discipline since "it already 'active' through homework assignment and laboratories"(p. 1).

According to Felder and Brent (2009), students in active learning will responds to the question, problem or any type of challenge either as an individual or in a small group (p. 1). Besides, McConnell, Steer, and Ownes (2003) add that "active learning can foster growth of thinking skill and promote science literacy"(p. 205). As to date, there are few active learning approaches that have been used in application of engineering program which is believed also suitable for Vocational Education and Training approach. Common approach that has been using are Problem Based Learning, Project Based Learning, CDIO, Collaborative Learning, Inquiry-Based, Learning and etc (Leung & McGrath, 2010; M. Prince, 2004).

Whilst the application of active learning in engineering is widely reported (Catts, Falk, & Wallace, 2011; M. Prince, 2004; Michael Prince & Felder, 2007), the best suitable approach for Vocational Education and Training still remain unclear. Thus, the rationale for further discussion is to understand and compare each approach in order to select the most suitable method for Vocational Education and Training application. However, only three approaches are highlighted throughout the discussion namely Problem Based Learning, Project Based Learning and CDIO which are also commonly used in engineering program.

2.2.2. Problem-Based Learning

Problem-Based Learning is widely used nowadays. It is believed to be an effective and ideal teaching approach for the 21st century. Most researchers agree that Problem-Based Learning is a student-centered approach which focuses on real-life contexts in order to stimulate a series of skills such as critical thinking, research and collaboration during the learning process(Ariffin et al., 2004; Grigg & Lewis, 2013; Yusof et al., 2004). Problem-Based Learning was initially used by the Medical School of the McMaster University in Canada at the end of the 1960s (Akınoğlu & Tandoğan, 2007; De Graaf & Kolmos, 2003). It was then applied to other disciplines, including law, business studies, dentistry, economics, engineering and education (Akınoğlu & Tandoğan, 2007; Grigg & Lewis, 2013; Michael Prince & Felder, 2007).

In Problem-Based Learning, the primary goal of the approach is to enhance learning by requiring learners to solve problems (Hung, Jonassen, & Liu, 2008). Thus, the learning process starts when students are given an ill-structured and real world set of problem instead of direct lectures (M. Prince, 2004; Michael Prince & Felder, 2007). Ward and Lee (2002)pointed out that “by using the central concept of this approach, students will learn the content as effectively as through lecture by attempting to solve realistic problem”(p. 18). In this case, facilitators or instructors are required to develop the student’s intrinsic interest in the subject matter, by emphasizing learning as opposed to recall, promoting group work and helping students to become self-directed learners(Hmelo-Silver, 2004). As compared to the traditional method, the role of teacher / lecturer now changes as they need to facilitate the learning process rather than to provide knowledge to the student (Savery, 2006).

Apart from that, Savin-Baden (2000) defined Problem-Based Learning as “organizing the curricular content around problem scenarios rather than subjects or disciplines”(p. 2) He also added that this approach is “characterized by flexibility and diversity in the sense that it can be implemented in a variety of ways and across different subjects and disciplines in a diverse context”(p. 3) . This statement is also agreed by de Graaff and Kolmos (2007) as “the solution of the problem can extend beyond traditional subject-related boundaries and methods”(p. 658). Thus, according to Savin-Baden (2000) “this ‘new’ diverse curricular helps students to ‘make sense’ for themselves where students have been enabled to understand their own situations and frameworks so that they are able to perceive how they learn, and how they see themselves as future professionals” (p. 2).

Another important element of the Problem-Based Learning approach is that the learning activity is handled by a small group of students rather than a big group **(**Barrows, 2006). Therefore, the aim of a small group session will encourage students to adopt deep learning and to be a self-directed active learner (de Graaff & Kolmos, 2007). This approach provides a learning environment which emphasizes on higher order thinking skills, multi-disciplinary learning, independent learning, teamwork and communication skills (Hmelo-Silver, 2004). Thus, Engel (1991) as cited by Ward and Lee (2002) mentioned that Problem-Based Learning has two distinct goals: to learn a required set of competencies or objectives and to develop problem solving skills that are necessary for lifelong learning (p. 18). Nevertheless, Savin-Baden (2000) added that students works in groups or teams to solve or manage these situations but they are not expected to acquire a predetermined series of ‘right answers’(p. 3). A basic understanding of the Problem-Based Learning approach as compared to the traditional method is compared in Table 1.

Many studies report the effectiveness of the application of the Problem-Based Learning approach in the engineering discipline (Borgen & Hiebert, 2002; De Graaf & Kolmos, 2003; Northwood, Northwood, & Northwood, 2003; Yusof et al., 2004). The changes are made as most educators believe that this approach creates a viable alternative in producing a competent engineering graduate as compared to the traditional method. Various definitions, concepts and principles on the Problem-Based Learning approach have led to different applications among institutes and educators.De Graaf and Kolmos (2003) have compared a model used by the Dutch approach of directing the learning process through problem analysis and the Danish model of project-organised learning(p. 657). However, Borgen and Hiebert (2002) added that the implementation may vary and can be implemented at several levels according to the subject level, course level and institutional level (Borgen & Hiebert, 2002). While other educators struggling to find a suitable approach in Problem-Based Learning, Republic Polytechnic in Singapore introduced a unique approach titled ‘one day one problem’ which was integrated into the Problem-Based Learning curriculum(O’Grady & Alwis, 2002).

2.2.3. Project-Based Learning

Project-Based Learning is another innovative method that is believed to provide multiple strategies in the learning process in the 21st century (Bell, 2010; Ehrie; Musa, Mufti, Latiff, & Amin, 2012). In Project-Based Learning, students possess their knowledge through an inquiry which is the starting point in their learning process (Bell, 2010). Similar to Problem-Based Learning, this approach is student driven and teacher’s facilitate it by giving a problem or question to a group of students (Bell, 2010; Kubiatko & Vaculová, 2011). Kubiatko and Vaculová (2011) simplified the definition as a “solution of a problem by groups of students within a specified time period, leading to the creation of a product(e.g.; thesis, report, model or etc)” (p. 66). This approach develops a student to work cooperatively and think independently (Ehrie; Kubiatko & Vaculová, 2011). On top of that, Shaffner (2003) added that Project-Based Learning is not only a new way of learning, but also an approach to work together.

Similar to Problem-Based Learning, it is an instructional method which allows students for deep learning as compared to rigid lesson plan that lead to specific learning outcome. In other words, it requires the student to be actively involved during the learning process (Kubiatko & Vaculová, 2011). Using problems in the learning process, students need to create a concrete artefact that involves designing an end product which forces students to think about all the steps involved. Thus, it allows a student to create their own pathway in the learning process. M. Prince (2004) added that the culmination of the project is normally a written or oral report, summarizing what is done and what the outcome was. Another important feature of Project-Based Learning is the possibility of using multidisciplinary knowledge in completing their task(Kubiatko & Vaculová, 2011).

The application of a Project-Based Learning approach as compared to traditional approach, Michael Prince and Felder (2007) mentioned that “studies have yielded results that similar to those obtaining for Problem-Based Learning, including significant positive effects on problem skills, conceptual understanding and attitudes to learning” (p. 16). Meanwhile, as compared to Problem-Based Learning, many researchers believe that the Project- Based Learning approach is more suitable for engineering application (Mills & Treagust, 2003; Morris, 1996). According toMills and Treagust (2003) , this is due to the “nature of the engineering profession, which is more familiar with the concept of a project in their professional practice” (p. 13). Kubiatko and Vaculová (2011) added that Project-Based Learning is “more related to professional reality as the learning process normally takes longer than the time to complete the project given.” Besides, the implementation of Project-Based Learning is assumed to be a “directed to the application of knowledge as compared to Problem-Based Learning which is more on the acquisition of knowledge”(p. 69). Thus, it is normally used in a science subject as designing a project is relevant to this approach. Furthermore, it will engage students with authentic exploration of concept and principle in completing the learning process.

However, Nepal and Jenkins (2011) added that some engineering student dislike this approach as they need to adopt a self-directed learning in order to complete un-clear and open-ended tasks (p. 338). Besides, Mills and Treagust (2003) highlighted that students may gain less in fundamental aspect as compared to conventionally taught acquired. Moreover, he also arises on the independent skills as students might too rely on team working in completing their project given. On top of that, the effectiveness of the Project-Based Learning implementation is based on a few factors which are prior knowledge and skills, subject selection, individual learning capabilities and time management (Hsu & Liu, 2005). Michael Prince and Felder (2007)added that the challenge of Project-Based Learning is to “define projects with a scope and level of difficulty appropriate of the class, and if the end product is a constructed device or if the project involves experimentation, the appropriate equipment and laboratory shop facilities must be available” (p. 16).

2.2.4. CDIO

Originated from Massachusetts Institute of Technology (MIT) America, CDIO or ‘Conceive, Design, Implement and Operate’ is another active learning approach that is designed specifically for application in the engineering discipline. It is derived from the statement that ‘engineers engineer’ and run based on specific standard syllabus that focusing on engineering fundamental in the context of Conceive, Design, Implement and Operate (Bankel et al., 2003; Crawley, 2001). The aim of CDIO is to define a specific outcome in terms of learning objectives of the person as well as necessary skills related to engineering practice (Bankel et al., 2005; Crawley, 2001). This goal then leads to a basis for designing suitable curricula that is suitable to any undergraduates engineering programme. The syllabus was also derived from various inputs from students, faculties, industries, alumni, academia, government bodies as well as professional societies.

Berggren et al. (2003) stated that “the overall goals of CDIO are:

- Master a deep working knowledge of technical fundamentals.
- Lead in the creation and operation of new products and systems.
- Understand the importance and strategic value of their future research work” (p. 49).

In CDIO, the syllabus is constructed as an integrated condensed curriculum that highlighted multiple outcomes simultaneously. In Crawley (2001), this syllabus comprises of “three levels of contents with four main expectations which are:

1. Technical Knowledge and Reasoning
2. Personal and Professional Skills
3. Interpersonal Skill
4. Conceiving, Designing, Implementing and Operating System in the Enterprise and Society Context” (p. 4)

As to date, there are revised and updated to the CDIO syllabuses since originally written in 2001 in order to add related missing requirement. (Crawley, Malmqvist, Lucas, & Brodeur, 2011).

In implementing CDIO, there are many teaching and learning methods used which is called integrated learning. According to Crawley (2007) “integrated learning means that students learn and practice personal and interpersonal, and product, process, and system building skills, while gathering technical and discipline knowledge”(p. 134). He also added that this method is effective in integrating skills with disciplinary knowledge. In addition to that, active learning methods are used in order to engage students directly in thinking and problem solving activities while experiential learning is used to engage students by setting teaching and learning contexts that stimulate engineering roles and practice. In this case, Problem and Project-Based Learning approach is used as a tool to implement the CDIO pedagogy in order to enhance the learning process (Kaikkonen & Lahtinen).

3. Discussion: Problem-Based Learning and Vocational Education and Training - Where does it fit?

The Chinese philosopher Confucius stressed the importance of active involvement in the learning process with his quote:

Talk to me… and I will forge
Show me… and I will remember
Involve me …. And I will understand
Step back… and I will act (de Graaff & Kolmos, 2007)

This statement is a synonym to the application of active learning in the current learning environment. Even though his statement was initiated back in 500B.C, the relevance of his thought is significant in education nowadays. The traditional method of 'chalk and talk' deviates from current needs that require graduates to have multiple competencies which is a skills requirement of the 21st century. In order to achieve the target, a suitable pedagogy should be implemented parallel to the needs. Thus, the application of a Problem-Based Learning approach is believed to give a positive impact in Vocational Education and Training as it involves practical and hands-on experience. In support to that, Hanney and Savin-Baden (2013) highlight that Problem-Based Learning is a "relatively mature pedagogy, with a distinct theory of learning, that places the process of knowledge acquisition as its core"(p. 8). This approach was initially started in the1960's for a medical field and later expanded to the engineering field where Aalborg University was one of the first to implement it(Kolmos et al., 2007). Few existing models are available in a Problem Based Learning environment proves that this approach has been well accepted across the world and many other disciplines started to adopt this approach(De Graaf & Kolmos, 2003; Hung et al., 2008; Masek & Yamin, 2010). Besides, there are many studies which reveal the effectiveness of this approach in comparison to traditional approach (Masek & Yamin, 2010; Northwood et al., 2003; Yusof et al., 2004).

In application of Problem-Based Learning in Vocational Education and Training, the underlying principle of this approach is contains in the word 'problem' itself. The use of problem at the start of the learning process is to create curiosity amongst students, encouraging them to explore the knowledge. Kollias (2011) mentioned that 'learning to learn' is another competency that should be explored as a skill among Vocational Education and Training student (p. 1). He also added that "the 'learning to learn' has nothing to do with knowledge and skills but has more of a disposition towards learning new things"(p. 1). In other words, he suggests how to cultivate intrinsic value in order to encourage for lifelong learning. Thus, curiosity embedded in a Problem-Based Learning approach can encourage deep learning as well as to motive students to go further.

Another major impact of the Problem-Based Learning approach in Vocational Education and Training graduates is the effectiveness of enhancing generic skills. As the collaborative concept is an important principle that is highlighted in this approach, the learning setting is conducted in a group rather than an individual approach in order to cultivate cooperation amongst members. Hence, the learning process in Problem-Based Learning is stimulated by discussions in small groups of student. According to Johnson, Johnson, and Stanne (2000), cooperative learning exists when students work together to accomplish shared learning goals. In this situation, team working provides a much healthier learning environment rather than creating competition amongst students. In addition to that, this approach provides students with the opportunity to prepare for professional life, by practical training through group coordination and being proficient team member. This can be achieved when students learn to co-operate amongst themselves whereby a majority of the learning processes take place in groups. Thus, this approach helps students to develop their personal growth and competencies as well as motivation towards their professional career (Kolmos et al., 2007; Nopiah, Zainuri, Asshaari, Othman, & Abdullah, 2009).

On top of that, students who are working in groups will learn and teach other and promote good relationships, improve social support and foster self-esteem (Nopiah et al., 2009; M. Prince, 2004; WORKGROUPS, 2000). In other words, the Problem-Based Learning approach helps to improve student's interpersonal skills as many studies asserted its effectiveness, particularly in the application to the engineering discipline(Ariffin et al., 2004; Yusof et al., 2004). Besides, Salleh et al. (2007) reveal that using Problem-Based Learning for students that previously used exam oriented schooling system, had gain significantly improve their generic skills development such as leadership, analytical thinking, and conflict management and etc. Surprisingly, not only the educators realise the effectiveness of this approach, most of the students seem to appreciate this new concept as they realise the positive benefit in their communication skills as well as their interpersonal skills such as self-confident (Yusof et al., 2004)

Besides, with common understanding that Vocational Education and Training is a bridge to market and the economy, it is believed that this approach is able to relate between education and the working environment. Application of real life problem in the learning process can significantly nurture their thinking skill relevant to the actual working environment (Ward & Lee, 2002). Apart from that, the use of ill-structured problems allows students to explore more on related area. In this case, the student will learn and gather information by experiencing learning through the development of a solution. Besides, it allows the student to lead their path and determine their learning direction. Thus, this will motivate them to be confident and independent(Northwood et al., 2003).

Apart from that, practical and hands-on activities already reflect 'active learning' in Vocational Education and Training context, where similar concepts of active learning can easily implement from a Problem-Based Learning approach. While 'active learning' in a Vocational Education and Training context is mainly to improve skill competencies, the application of Problem-Based Learning in the Vocational Education system can enhance students generic skills. Thus, application of the Problem-Based Learning approach in Vocational Education and Training is believed to provide better graduates both technically as well as in personal competency.

4. Conclusion

Based on the finding of the discussion, the application of the Problem-Based Learning approach in Vocational Education and Training environment can improve employability skills such as interpersonal skill, communication skill, problem solving and life-long learning ability. As the aim of Vocational Education and Training approach is to provide the students with the ability to master the practical and hands-on skills, there is less concern for them to acquire factual knowledge and critical thinking as compared to academic education.

However, if technical competency is argued in Vocational Education and Training environment, there will be possible research in designing a suitable model that integrate generic skills as well as hands-on skills and technical competency. In this case Project–Based Learning is an option which is more suitable in practical application. The idea of a Problem led Project-Based Learning or Problem-oriented and project-based Learning (POPBL) is possible option to be looked at as a new learning approach as it combines Problem and Project-Based Learning principles in order to fulfill necessary competencies and requirements. In this case, important elements and characteristics of each approach can be used as the main backbone in designing the model with regards to Vocational Education and Training application.

Thus, it is concluded that the application of active learning particularly the Problem Based Learning approach, to enhance employability skill among vocational students. This new paradigm in the education system is hoped to produce students that comply with 21st century skills requirements, which is also the ultimate aim of all learning and teaching methods.

5. Tables

Table 1: Characteristics of traditional learning and Problem-Based Learning.

Adapted fromBarrows (1996) cited in Grigg and Lewis (2013)

	Traditional	**PBL**
Role of the tutor	Lecturer	Facilitator or guide
Curriculum	Subjects	Problems
Audience disposition	Passive	Active
Organisation	Large classes	Small groups
Approach	Tutor-directed	Self-directed

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References

Adams, Jonathan, Kaczmarczyk, Stefan, Picton, Phil, & Demian, Peter. (2011). Problem solving and creativity in engineering: conclusions of a three year project involving reusable learning objects and robots. *Engineering Education: Journal of the Higher Education Academy Engineering Subject Centre, 5*(2), 4-17.

Akınoğlu, Orhan, & Tandoğan, RO. (2007). The effects of problem-based active learning in science education on students' academic achievement, attitude and concept learning. *Eurasia Journal of Mathematics, Science & Technology Education, 3*(1), 71-81.

Allen, Charles R. (1919). The Instructor, The Man, and The Job.

Ariffin, Abu Hassan Mohd , Yusof, Khairiyah Mohd , Hamid, Mohd. Kamaruddin Abd , Hassim, Mimi Haryani , Aziz, Azila Abd. , & Hassan, Syed Ahmad Helmi Syed (2004). A review and survey of Problem-Based Learning application in Engineering Education.

Azizan, Farahiza Zaihan. (2010). *Blended Learning in Higher Education Institution in Malaysia.* Paper presented at the Proceedings of Regional Conference on Knowledge Integration in ICT.

Bankel, Johan, Berggren, Karl-Fredrik, Blom, Karin, Crawley, Edward F, Wiklund, Ingela, & Östlund, Sören. (2003). The CDIO syllabus: a comparative study of expected student proficiency. *European Journal of Engineering Education, 28*(3), 297-315.

Bankel, Johan, Berggren, Karl-Fredrik, Engström, Madelaine, Wiklund, Ingela, Crawley, Edward F, Soderholm, DH, . . . Östlund, Sören. (2005). Benchmarking engineering curricula with the CDIO syllabus. *International Journal of Engineering Education, 21*(1), 121-133.

Barrows, Howard S. (1996). Problem-based learning in medicine and beyond. A brief overview. *New directions for teaching and learning*, 3-11.

Barrows, Howard S. (2006). Problem-based learning in medicine and beyond: A brief overview. *New directions for teaching and learning, 1996*(68), 3-12.

Bell, Stephanie. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House, 83*(2), 39-43.

Berggren, Karl-Frederik, Brodeur, Doris, Crawley, Edward F, Ingemarsson, Ingemar, Litant, William TG, Malmqvist, Johan, & Östlund, Sören. (2003). CDIO: An international initiative for reforming engineering education. *World Transactions on Engineering and Technology Education, 2*(1), 49-52.

Bonwell, C.C., & Eison, J.A. (1991). Active Learning: Creating Excitement in the Classroom. ERIC Digest. *ASHE-ERIC Higher Education Reports, The George Washington University*.

Borgen, W., & Hiebert, B. (2002). Understanding the context of technical and vocational education and training. *Technical and Vocational Education and Training in the 21st Century: New Roles and Challenges for*.

Catts, Ralph, Falk, Ian, & Wallace, Ruth. (2011). *Vocational learning : innovative theory and practice* (1st ed.). Dordrecht ; New York: Springer.

Chappell, C. (2003). Researching Vocational Education and Training: where to from here? *Journal of Vocational Education and Training, 55*(1), 21-32.

Chickering, A.W., Gamson, Z.F., & Poulsen, S.J. (1987). Seven principles for good practice in undergraduate education.

Crawley, Edward F. (2001). The CDIO Syllabus. *A Statement of Goals for Undergraduate Engineering Education*.

Crawley, Edward F. (2007). Rethinking engineering education: the CDIO approach (POD).

Crawley, Edward F, Malmqvist, Johan, Lucas, William A, & Brodeur, Doris R. (2011). *The CDIO Syllabus v2. 0. An Updated Statement of Goals for Engineering Education.* Paper presented at the Proceedings of 7th International CDIO Conference, Copenhagen, Denmark.

De Graaf, Erik, & Kolmos, Anette. (2003). Characteristics of problem-based learning. *International Journal of Engineering Education, 19*(5), 657-662.

de Graaff, ERIK, & Kolmos, ANETTE. (2007). History of problem-based and project-based learning. *Management of change: Implementation of problem-based and project-based learning in engineering*, 1-8.

Dede, Chris. (2010). Comparing frameworks for 21st century skills. *21st century skills: Rethinking how students learn*, 51-76.

Ehrie, Ryan. Project Based Learning.

Eichhorst, Werner, Rodriguez Planas, Núria, Schmidl, Ricarda, & Zimmermann, Klaus. (2013). A roadmap to vocational education and training systems around the world.

Engel, Charles E. (1991). Not just a method but a way of learning. *The challenge of problem-based learning*, 21-31.

Eyre, Elezabeth. (2011). European research reveals vocational education and training's lack of status. Retrieved from www.trainingjournal.com website:

Felder, Richard M, & Brent, Rebecca. (2009). Active learning: An introduction. *ASQ Higher Education Brief, 2*(4), 122-127.

Grigg, Russell, & Lewis, Helen. (2013). *'Thinking and learning together'. Promoting critical thinking skills through Problem-Based Learning in teacher education.* Paper presented at the 16 th International Conference on Thinking (ICOT).

Hanney, Roy, & Savin-Baden, Maggi. (2013). The problem of projects: understanding the theoretical underpinnings of project-led PBL. *London Review of Education, 11*(1), 7-19.

Hmelo-Silver, Cindy E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235-266.

Hsu, Roy Chaoming, & Liu, Wen-Chung. (2005). *Project based learning as a pedagogical tool for embedded system education.* Paper presented at the Information Technology: Research and Education, 2005. ITRE 2005. 3rd International Conference on.

Hung, Woei, Jonassen, David H, & Liu, Rude. (2008). Problem-based learning. *Handbook of research on educational communications and technology, 3*, 485-506.

Johnson, D.W., Johnson, R.T., & Stanne, M.B. (2000). Cooperative learning methods: A meta-analysis. *Minneapolis, MN: University of Minnesota. Retrieved April, 1*, 2004.

Kaikkonen, Olli, & Lahtinen, Teijo. PROBLEM AND PROJECT BASED CURRICULUM VS. CDIO.

Kollias, Andreas. (2011). Learning to learn in vocational education and training from an equity perspective: a conceptual framework. *The FARE Project: Bruselas, Comisión Europea*.

Kolmos, Anette, Kuru, Selahattin, Hansen, Hans, Eskil, Taner, Podesta, Luca, Fink, Flemming, . . . Soylo, Ahmet. (2007). Problem based learning: TREE-Teaching and Researc in Engineering in Europe.

Kubiatko, Milan, & Vaculová, Ivana. (2011). Project-based learning: characteristic and the experiences with application in the science subjects. *Energy Educ Sci Technol Part B, 3*, 65-74.

Leung, Anita Sui Man, & McGrath, Simon. (2010). An Effective Learning Model to Support People Development: The Emerging Approach of The Hong Kong Institute for Vocational Education. *International Education Studies, 3*(4), p94.

MacDonald, Stephen, Nink, Carl, & Duggan, Stephen. (2010). Principles and Strategies of a Successful TVET Program. (October).

Masek, Alias, & Yamin, Sulaiman. (2010). Problem based learning model: A collection from literature. *Asian Social Science, 6*(8), P148.

McConnell, D.A., Steer, D.N., & Ownes, KD. (2003). Assessment and active learning strategies for introductory geology courses. *Journal of Geoscience Education, 51*(2), 205-216.

Mills, Julie E, & Treagust, David F. (2003). Engineering education—Is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education, 3*, 2-16.

Morris, P. (1996). Asia's four little tigers: a comparison of the role of education in their development. *Comparative Education, 32*(1), 95-110.

Musa, Faridah, Mufti, Norlaila, Latiff, Rozmel Abdul, & Amin, Maryam Mohamed. (2012). Project-based Learning (PjBL): Inculcating Soft Skills in 21< sup> st</sup> Century Workplace. *Procedia-Social and Behavioral Sciences, 59*, 565-573.

Nair, Chenicheri Sid, Patil, Arun, & Mertova, Patricie. (2009). Re-engineering graduate skills–a case study. *European Journal of Engineering Education, 34*(2), 131-139.

Nepal, Kali Prasad, & Jenkins, Graham A. (2011). *Blending project-based learning and traditional lecture-tutorial-based teaching approaches in engineering design courses.* Paper presented at the manuscript for AaeE 2011 conference.

Nilsson, Anders. (2010). Vocational education and training–an engine for economic growth and a vehicle for social inclusion? *International Journal of Training and Development, 14*(4), 251-272.

Nopiah, Zulkifli Mohd, Zainuri, Nuryazmin Ahmat, Asshaari, Izamarlina, Othman, Haliza, & Abdullah, Shahrum. (2009). improving generic skills among engineering students through problem based learning in statistik engineering course. *European Journal of Scientific Research, 33*, 270-278.

Northwood, Melissa D, Northwood, Derek O, & Northwood, Marilyn G. (2003). Problem-Based Learning (PBL): from the health sciences to engineering to value-added in the workplace. *Global J. of Engng. Educ, 7*(2), 157-163.

O'Grady, Glen, & Alwis, WAM. (2002). *One day, one problem: PBL at the Republic Polytechnic.* Paper presented at the 4th Asia Pacific Conference in PBL. Hatyai, Thailand.

Prince, M. (2004). Does active learning work? A review of the research. *JOURNAL OF ENGINEERING EDUCATION-WASHINGTON-, 93*, 223-232.

Prince, Michael, & Felder, Richard. (2007). The many faces of inductive teaching and learning. *Journal of College Science Teaching, 36*(5), 14.

Rojter, Josef. Inductive-based Pedagogy in Engineering ScienceSubject.

Salleh, Berhannudin Mohd, Othman, Hussain, Esa, Ahmad, Sulaiman, Abdullah, & Othman, Hasyamudin. (2007). *Adopting problem-based learning in the teaching of engineering undergraduates: A Malaysian experience.* Paper presented at the International Conference on Engineering Education, Portugal: Coimbra, September.

Savery, John R. (2006). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-based Learning, 1*(1), 3.

Savin-Baden, Maggi. (2000). *Problem-based learning in higher education: Untold stories*: Society for Research into Higher Education London, England.

Selvadurai, Sivapalan, Choy, Er Ah, & Maros, Marlyna. (2012). Generic Skills of Prospective Graduates from the Employers' Perspectives. *Asian Social Science, 8*(12), p295.

Shaffner, Marian. (2003). *Project-Based Learning.* Paper presented at the World Conference on Educational Multimedia, Hypermedia and Telecommunications.

UNESCO. (2002). Technical and Vocational Education and Training for the Twenty-first Century: UNESCO Recommendations.

Ward, Janet D, & Lee, Cheryl L. (2002). A Review of Problem-based Learning. *Journal of Family and Consumer Sciences Education, 20*(1), 16-26.

WORKGROUPS, C.L. (2000). Dynamics of peer education in cooperative learning workgroups.

Yusof, Khairiyah Mohd, Aziz, Azila Abdul, Hamid, Mohd Kamarudding Abdul, Hassan, Mohd Ariffin Abu, Hassim, Mimi Haryani, Hassan, SAHS, & NMA, Azila. (2004). *Problem based learning in engineering education: a viable alternative for shaping graduates for the 21st century.* Paper presented at the Conference on Engineering Education, Kuala Lumpur.

Zaharim, Azami, Omar, MZ, Yusoff, YM, Muhamad, N, Mohamed, A, & Mustapha, Ramlee. (2010). *Practical framework of employability skills for engineering graduate in Malaysia.* Paper presented at the Education Engineering (EDUCON), 2010 IEEE.

Implementation of Problem Based Learning (PBL) - in a Malaysian Teacher Education Course: Issues and Benefits From Students Perspective

Mohamad Termizi Borhan[a] and Sopia Md Yassin[b]

[a]UNESCO Chair in Problem Based Learning,
Aalborg University, Nybrogade 8, Room 1.125, Aalborg, 9000 Denmark and
[a b]Faculty of Science and Mathematics,
Universiti Pendidikan Sultan Idris, 35900, Tanjong Malim, Perak, Malaysia

Abstract

The paper describes an employment of a Problem Based Learning (PBL) approach in a Malaysian graduate teacher education course. The discussions focus on how PBL was introduced, the PBL tasks and explore issues and benefits perceived by students. Data were obtained from journal reflections, interviews and field note of observations. All types of data were analyze using inductive analytical approach. The result indicated that students were struggling at the preliminary phase of PBL, require more time in PBL learning process and link the acquisition of skills and group working process as benefits of participating in PBL class. The study also reiterated the important to align different curriculum elements and to address contextual elements in designs in effort to achieve designs that sensitive to local elements.

Keywords: Curriculum design, teacher education, issues, benefits.

1. Introduction

There has recently been a shift in teaching and learning approaches in higher education from behaviourism to cognitive and generic skills (Murray-Harvey et al., 2004). According to Casey and Hawson (1993), the focus of the cognitive approach to education is more on the thinking processes quality, rather than the accuracy of the answers the learners produce. PBL is a student-centred learning that assumes the idea of a student have the ability to "learn by doing" and therefore acknowledges that they play an active role in their learning as problem-solvers, and think in critical and creative ways (Barron et al.,1998). PBL is an instructional methods that centralized the content of learning around the problems, rather than a series of pre-determined content in conventional teaching approach, in which group of students are presented with an ill-structured problems or case which they work collaboratively to deal with the problems, usually for a week or longer, depending on the complexity of the problem scenarios. PBL encourage learners to apply problem solving skills, critical thinking and content knowledge to the real-world issues and problems. Students assume more responsibility in the learning compared to the conventional approach as they need to find the information they need to solve the problems given, which in turn inculcate the self-directed learning. PBL was first initiated in the late 1960s at McMaster University and has since spread around the world mainly in medical education. There are variety of PBL models practiced worldwide and across variety of fields since its initiative at. However, in general all PBL approaches share six core characteristics as described by Barrows (1996):

Table 1. Characteristics of PBL approach

Learning is student-centred
Learning occurs in small group tutorials
Teachers are facilitators or guides
Problems form the organizing focus and stimulus for learning
Problems are a vehicle for the development of clinical problem-solving skills
New information is acquired through self-directed learning

Source: After Barrows (1996).

PBL represent the constructivist theory where knowledge is individually constructed and socially co-constructed from interaction with the environment (Hung et al., 2008). Constructivist learning approaches emphasize learning and how to think and understand. A constructivist classroom setting involves authentic learning activities and a real-world context where students learn how to question things and apply their natural curiosity to the world. As a result, constructivism gives students ownership of what they learn and encourages higher retention, as learners seek meaning for themselves and not the meaning constructed by their teachers (Hmelo and Evensen, 2000).

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

Entailing these issues, Malaysia´s Ministry of Higher Education has called universities to adapt outcome-based education (OBE) in their teaching strategy. OBE is a student-centred approach to education focuses on the learning outcome from instruction. In OBE, students is not only expected to possess knowledge, but also equipped with skills and qualities upon the graduation. Hence, teaching and learning in higher educations should be steered in accordance with the desired outcomes. Responding to this trend, PBL has been adopted in Malaysia within a variety of fields and has become one of the promising innovations in Malaysian higher education teaching and learning settings and has gained considerable prominence in field of engineering, ICT and multimedia, physics, and medical and dental education, (eg: Barman, 2005; Mohd-Yusof et al., 2005 and Said et al., 2005). PBL was introduced in the Malaysian education context, particularly in health sciences, in the early 1970s (Achike and Nain, 2005), yet its growth was slow and scarcely documented. However, by the 1990s, a growing number of medical and non-medical schools began to introduce PBL; for example, the Universiti Teknologi Malaysia (UTM), a public, technology-based university spearheaded PBL within its various engineering schools. Aiming to produce more high-quality graduates, it was argued that an engineering graduate should be equipped with skills in communication, team working, problem solving and life-long learning (Mohd-Yusof et al., 2005). Said et al., (2005) likewise posit the need for electrical engineering graduates equipped with analytical skills, critical and lateral thinking, technical skills, team work and time management. Overall then, PBL in Malaysian higher education is more integrated into engineering and medical schools, than in other subject areas including in teacher education fields.

From favourable collective research outcomes regarding PBL implementation, it appears to be a good reason to introduce PBL in teacher education. Like any other profession, teachers are urged to be more responsive and relevant to ever-changing issues regarding schools and students. In particular, the role of today´s teachers is not merely limited to teaching and classroom matters, but also to involve in multiple roles like researcher, curriculum planner, team leader and decision maker. As Dean (1998) posits, issues like inclusive classrooms, diversity of student´s group, and emergence of new technologies that present a tremendous challenges to beginning teachers. Therefore it is imperative to develop beginning teachers with necessary skills and competences deemed relevant to face the reality if classrooms. From literature review, PBL gains attention in teacher education field and has been associated with positive change of knowledge, skills and competences (Merseth, 1996). This paper report on the PBL employment in a graduate science teacher education course in Malaysia. The paramount objectives of incorporating PBL in the course was to empower them to make transition from learning to research since students will embark on their research projects in the proceeding semester. They need to be able to apply the knowledge they have gained in the current course to solve problems and serve as the fundamental information in doing their research projects. Science teacher education programs are compatible with the PBL approach as there are a lot of problem scenarios from practice of teacher professions, as well as literature related to the practice of science education in school settings (Peterson and Treagust, 2001). Therefore, PBL was used so that they could learn the skills and competences needed to solve problems and embark on research projects. In relation to the design and implementation of PBL as an instructional approach, the goals of redesigning the course to PBL were 4 folded: to experience and understand PBL in practice, to contribute to the knowledge base of student-centred approach in higher education, to provide a variety of opportunities exploring issues related to science teaching and learning in school and to expose and engage teachers in authentic learning experiences, that would stimulate them to adopt student-centred learning in their own classrooms. However for the purpose of reporting, we converged the aims of the paper to:

1. Describe the PBL implementation process including the course design, the assessment procedures and roles of facilitators
2. Elicit student responses of their participation in the PBL class particularly on issues and perceived benefits.

2. Course Background

The Master of Education (Science Education) degree in Universiti Pendidikan Sultan Idris (UPSI) is either a 1.5-year programme for full-time students, or a 2-year programme for part-time students. This course is designed to enable students to analyse the management of learning in science education. In particular, the course objectives for learners were to:

- Analyse management theories in terms of their characteristics and purposes as well as their relevance in science education;
- Evaluate the effectiveness of various types of management models;
- Discuss critically the best practices to maximize learning and teaching;
- Discuss and develop instruments to assess learning;
- Collaborate with group members to perform assigned tasks.

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

Topics include theories of management, school leadership with an emphasis on constructivist leaders, management of assessment, and management of science department. The intellectual scope of discussion covers perspectives such as teaching and learning contexts, service quality, assessment and how management can foster science learning. Before the commencement of the semester, the course was redesign to a PBL approach, a student guide developed to assist students learning in a new constructive learning environment, and a set of assessment procedures determined. Generally, we are adopting a Design Based Research (DBR) approach to redesign the course into a PBL approach. DBR accelerates the link between theory and practice, in which our intention in designing the course is to retain the rigorous theories and principles underlying PBL and address the contextual elements. Another important concerns in designing the course into PBL approach is the alignments of different curriculum elements. Kolmos *et al.*, (2009) proposed seven elements in the curriculum that need to be aligned prior to the PBL implementations; objective and knowledge, types of problem and project, progression and size, students´ learning, academic staff and facilitation, space and organization and assessment and evaluation.

3. Methods

The study employed semi-structured interview, semi-structured participant observations and students´ reflective journal as the means of data collection techniques. The in-depth, open-ended nature of semi structured interview was conducted with 8 randomly volunteered students at the conclusions of the semester. The purpose of the interview was explained verbally before the session started and participation was voluntary. The interview explored background information about the participants, their previous experience of group work, benefits and challenges of participating in PBL exercise in terms of collaboration with peers, the problem solving process and facilitation process. The interview was loosely structured to give opportunity to participants to form the interview from their own views and experiences (Seidman, 1998). Depending on the willingness of the participants to share and talk, each conversation lasted from 20 minutes to as much as 70 minutes and took place either in researcher´s office or at the campus location the student selected for their convenience. All fifteen interviews were tape-recorded and fully transcribed. Interview transcript were analyzed using inductive analytical approaches, a qualitative data analysis technique that use detailed readings of raw data to derive, theme, concepts or model through interpretations made from the raw data by a researcher across the interviews (Thomas, 2006). Each transcript was listened repeatedly to determined topic and sub-topics, which were then coded as categories. The list of categories give rose to themes after refining it by read comparatively against each transcript to seek for commonality and contradictions.

Observations were made when the PBL groups meet to deal with the tasks: identifying the facts, their ideas from the facts identified, learning issues and hypothesis and their action plan for problem solutions. During these sessions, we recorded our observations as written notes that were organized into field note journal. Field notes were used to gather, record and compile events happening in group discussions. The fields note describes information as to what we have directly seen or heard on-site through the course of the study. There is also a reflective part of the field note. The reflective part represents our reactions to the observations, experiences and thoughts during the observation sessions. The observation were used to create a rich description of the classroom environment and also help us to understand the development of some of the students´ conception. Students´ reflective journal was administered in specific weeks during the semester. Reflective journals consisted of individual reflections and group reflection. Generally, the reflective journal aims to get insight on how students learned through PBL, to make them aware of their own learning, and to enhance their metacognitive awareness about how learning occurs and which part should be improved. To analyze data from both observation and reflective journals, we adapt the content analysis technique. Content analysis were used to individually sort and organize data to achieve themes. In the final stage of analysis, themes from the interview transcripts, reflection, and field notes were compared to locate general pattern of similarities, points of clarification and points of contradictions using grounded theory (Strauss and Corbin, 1990). Multiple data collection strategies and data sources lead to a complete picture of our variables and also in such a way the strength of one particular strategy compensate for the weakness of another.

4. Description of the Course

4.1. The Students

32 Master of Education (Science) students signed up for the course that runs 14 weeks for 3 hours period per week, once in a week. The students assigned themselves into 7 groups. Thought students were informed about active and student-centred learning, and whilst they may have participated in group work previously, they were not familiar and

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

had never experienced PBL in which the group work is highly collaborative. Hence the first class meeting in the first week was devoted to introduce PBL to students. Pre-course notes on PBL were given prior to the commencement of the first class. Pre-course notes consist of introduction to PBL, characteristics of PBL, rationale for learning through PBL, depiction of PBL process, proposed steps to approach the problems, expectation to students and walk the class through a sample case as an introduction to the PBL process.

4.2. The PBL Tasks

PBL is a "problem first" learning approach, i.e. the starting point of learning is a realistic and contextualize problems scenario**.** Unlike the traditional curriculum content that was arranged according to the topic, theme and disciplines, PBL content is organized around problems. As students are new to PBL, it is reasonable for us to arrange the PBL scenarios in gradual manner- from simple problem scenario to a more complex problem scenario towards the end of the semester. Each problem scenario in the PBL class is designated for students in discussions to construct their own understanding, they shared their individual experiences and each group member makes a distinctive contributions (Wood, 1994). In our class, groups of students completed three PBL cases during the 14-week course.

Table 2. The PBL scenarios for the course

Topics in the course	Duration to complete the task	The ill-structured problems or scenarios presented as	Groups´ deliverables
i. Constructivism in science education	3 weeks	Video of a teacher teaching a group of primary school students on *Body Part* topic	Evaluation tools used to assess a constructivist in class
ii. Alternative conceptions in science topics	3 weeks	Research findings sample of *alternative conceptions of light* properties, and an invitation letter to publish a review article from a publisher	A review article about alternative conception among students in a chosen topic
iii. 21st century science learning skills	2 weeks	A competition poster to design a school science laboratory corresponds to the *21st century learning*	A layout plan for the 21st century science school laboratory.

To correspond to the PBL principles in designing the PBL scenarios, the above PBL scenarios are not so rigidly defined that there is only a simple and single ´right´ answer to. It is expected that each group will develop different approaches in dealing with the problems and students will learn more and expand their perspectives by critiquing and arguing with other group members while presenting their findings. Depending on the difficulty level of the PBL scenarios, students deal with the tasks in different time frames, from 2 until 3 weeks.

4.3. The PBL learning process

The class started with a short tutor introduction to the issues, followed by the scenario presentation for group discussions. Then a group representative will take tutor-prepared learning materials to their group and mutually work towards addressing the problems and issues. Generally in the first group discussions, students in groups brainstormed about the case given to them; listing out information they could find from the case, what are their thoughts and opinions on it, questions or inquiry they had and finally come out with the learning issues. Learning issues will guide students to do further research to answer the case. To facilitate students to be more concrete in articulating information during discussions, we suggested students to use the following headings in Table 3.

Table 3. Headings suggested to students to deal with the PBL cases

Fact	Idea	Learning Need/Issue	Action plan
What do we know?	What do we think?	What do we need to know?	What should we do?
-Information extracted from the problem scenario -Identification of term and notion -Ambiguous notion	-Possible causes/effects/ ideas/solution based on the fact identified -consider to use own experience and previous knowledge	-Phrase as questions that lead to the problem solution -Determine which question is worth researching and list out those irrelevant	-Activities to be carried out to answer the questions -Possible resources to consult to answer the questions -Task division

Source: adapted from Dean (2001), pg 11.

As students are novice and newly exposed to PBL, the headings are imperative for them to determine the fact of the case, develop feasible hypotheses underlying the problem, identify and finally divide learning issues for individual and independent research. Students take on different roles during each discussion like team leader that steer group direction, scriber to write and compile all the important information discussed, and regular members looking for the resources related to problems under scrutiny. Before the class is dismissed, each group is expected to divide the tasks among

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

respective group members for the individual studies period. Between problem-based tutorials, students engage in self-directed learning to deal with the tasks given. Students will carry out their individual studies period in the week before the second meeting of the sequence. In individual studies, students will mainly search for the resources relevant to the learning issues given to them, and prepared drafts for the next group discussions. Since most of them are part-timers and live apart, the students use email and internet extensively to connect to each other. They share and critique resources, and keep journals to support the group process during individual studies. Then during the second class meeting, they presented their findings to members of the group, both verbally and with drafts prepared. At this stage, some students may draw illustrations, clarify unclear parts and draw connections between prior knowledge and the tasks under discussions. Based on the collective works from each group member, the groups will decide a solution to the problems after reaching consensus. Upon reaching the consensus, the whole-class discussions are carried out. The aims of the whole-class discussions is to expose students with other groups´ solutions, and broaden their perspectives on the case. Table 3 succinctly laid out steps of learning process for each PBL cycle in our class. Table 3 succinctly laid out steps of learning process for each PBL cycle:

Table 4. Seven steps of learning process in PBL

Step 1:	Clarify terms and concepts not readily comprehensible
Step 2:	Define the problem
Step 3:	Analyse the problem
Step 4:	Draw a systematic inventory of the explanations inferred from Step 3
Step 5:	Formulate learning objective
Step 6	Collect additional information outside the group
Step 7	Synthesize and test a newly acquired information

Source: from Schmidt (1983), pg13

4.4. Facilitator´s Role

Throughout the course, my role was to facilitate and guide rather than provide information. In particular, my task is to consult with each group to assist them to clarify the PBL cases, consider variety types of resources, make sure they are still on the right tracks, suggest a better approach in group work and help them to meet the deadline. During the early semester, the facilitator can take a more dominant role in tutorial activity to guide students towards self-direction, and gradually reduce the facilitation and scaffolding as students become more and more familiar with the academic expectations being made of them (Ryan, 1993). In a more recent study, Mohd-Yusof et al., (2011) proposed more motivation and encouragement is given to students who are new to PBL than experienced students. This could be done by having more scaffolding and guidance in the preliminary PBL cycles, and gradually decrease the amount of facilitation as the semester increase. Unlike in medical settings which allocate one tutor for each of the PBL groups, but in my class we adapt the floating facilitation style. We went around the groups to facilitate group work, and probing students´ group with questions that lead students to activating their prior knowledge and experiences. Each group is also required to keep group´s logbook to monitor periodically their progression and to determine further scaffolding needed by each group. In the early semester, intense and more structured facilitation style was adopted to help students in their learning, and more independent and less structured of facilitation took place as students become more accustomed with PBL. Although we are not planning to conduct any formal lectures throughout the PBL sessions, we are still prepared for it, depending on the need or only when it is necessary. Furthermore, it may be necessary to introduce topics or provide overview information for higher level subject materials related to PBL scenario.

4.5. The Assessment Procedures

It is imperative to note that change in educational goals, content and approach in teaching and learning of a course will also require change in assessment methods since these educational elements are mutually interdependent, i.e. if one element is changed, this will lead to the change in other elements (Holgaard and Kolmos, 2009). Assessment procedures should be able to assess students learning in a way that reflects the PBL philosophy. PBL emphasize not only the acquisition of knowledge but also attributes, such as teamwork, communication skills, self-directed learning and information sharing. Hence, assessment in PBL should go beyond solely rely on factual recall. As Woods (2003) proposes, assessment in PBL should adopt the fundamental principles of testing the student in relation to the learning outcome and range of assessment methods.

Table 4. Assessment procedures lead to the final grade

Types of assessment	Detail		Weightage (%)
	i.) PBL1: Constructivism	-Presentation	10.0
		-Evaluation tool	10.0
		-Final deliverables	5.0
	ii.) PBL2:	-Critical review article	20.0

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

Group assessment	Alternative Conception	- Group Reflection	5.0
	iii.) PBL3: 21st Century Learning	-Presentation	10.0
		-Group Reflection	5.0
		-Final deliverables	10.0
Individual assessment	i.) Reflection 1 and Reflection 2		15.0
	ii.) Attendance and Participation		10.0
		Overall percentage	100.0

For assessment purposes, we divided the assessment into 2 categories; group assessment and individual assessment. Since students involve substantially in group working throughout the course, it is imperative to highlights our emphasize of group assessment to students. Furthermore, group assessment represents a bigger percentage than the individual assessment (in this case, group assessment represent 75% of overall assessment). To assess *presentations* (during both PBL1 and PBL3), we develop a rubric to assess group performance in three main traits; verbal, non-verbal and content. In verbal traits, we rated the enthusiasm and elocution. In non-verbal traits, we observe the eye contact, body language and poise. Although this is a rubric, we still emphasize on content delivered during the presentations. We assess the subject knowledge, content organization, key elements of content, and the mechanics. To assess group artifacts (e.g. *evaluation tool* and *critical review articles*), we are using rubrics. Rubric is an evaluation tool that describe the criteria for performances that deemed accurate to reflect content skills, process skills and learning results.

Reflection is an opportunity for students to reflect on the way they learn, and how they could improve as a team member to enhance collaboration and efficiency of group work. Furthermore, opportunity for reflection on learning process is an important aspect of PBL (Holen, 2000). In addition, the information from the journal reflection serves as a valuable resource for us to re-structure or revise the following PBL cycles. For grading purposes, the reflections (both individual and group reflections) represent 25% of overall assessments. In *Individual Reflection* (*Reflection 1* and *Reflection 2*), each student recorded their thinking about the group processing**,** what they have learned, peer evaluation of how individuals contributed to the overall effectiveness of the group, what roles do they take up, and issues, frustration and difficulties. To write a *group reflection*, students need agreement with the rest of the group members. In a way, group reflections could enhance their collaboration. In group reflections, students will describe how they start the discussions, strategy to enhance group collaboration, evaluate the PBL cases, how do they address the learning issues, resources used to deal with the tasks, and any prior preparation before attending the discussions. Both individual and group reflections were executed at the different time intervals. *Final deliverables* (in PBL1 and PBL3) marks are only granted for groups completed their presentation sessions and submit their related group works. The assessment of *attendance and participation* was based on students´ contribution to group and class discussions, and their active involvement in the learning process.

5. Result and Discussions

Analysis and coding of the data from three qualitative data collection techniques (semi-structured interview, participant observations and reflective journal) resulted in two categories for *Issues*, namely *initial anxiety and struggle, time insufficiency* and two categories for *perceived benefits* namely *skills improvement, development and acquisitions* and *group processing*. The results are presented and discusses through the use of quotes and narratives. The different type of sources were marks as follows; Individual Reflection (IR2_#), Group Reflection (GR1_#) and Interview (ES_#).

5.1. Issues

5.1.1. Initial anxiety and struggle

The anxiety and struggle in the early period of class was echoed by most students in both interviews and individual reflections. Uncertainty and difficulty in dealing with the task are among the prevalent comments. Here are some written comments and interview extracts:

- Hard to deal with the task at the beginning (IR2_25)
- “Unsure about what is supposed to do in the early semester”(ES_4).
- “At the preliminary week of the class, it was very difficult to deal with the tasks, it is like a big burden….we can feel the hardships.” (ES_2).
- “Do not sure what to do at first, but later on familiar learning in PBL environment” (ES_6)

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

Schmidt et al. (1992) reported that student needs at least 6 months to adapt to the new instructional method. As Lieux (2001) stated, students´ anxiety during the PBL is partly contributed from their concern about the sufficiency of content coverage. Some students clearly laid out to which phases of learning process they are struggling at the first tasks of PBL:

"During the latest PBL tasks, we are now sure what to do, and convince on it. But at the first tasks, we are a kind of unsure of what we should do, a bit confuse...We do not know how to fill in the FILA chart, during the second tasks, we are still not so sure yet. We do not sure where should we go, to which direction we should headed for." (ES_5).
-"During the first PBL tasks, we misunderstood of what we should do. Initially, we thought that we need to scrutinize on the contnet of the video or the content of the lesson the teacher teaches. During the first task (in the Constructivism topic), we are still ambigous on what to do, however we are actually become more comfortable while we know on what to do ."(ES_6).

This finding is supported by a study of students' assessments of PBL. In the introduction phase of PBL, Pereira et al. (1993) found that students are cautious about PBL, and to some extend condemned on the approach. Nonetheless, over time the students are more positive towards PBL, partly contributed by the support and commitment from the faculty.

The results are similar with Lai and Tang (1999) research on students response towards PBL. From the interview excerpts, students were reported of being frustrated at the beginning of the course, largely contributed by their uncertainty and unfamiliarity with PBL approach.

From above comments, it suggest that as students get familiar with the PBL learning approach, they become more comfortable and confident. Similar observations were also reported in a study by Schultz-Ross and Kline (1999). The authors found that the students´ dissatisfaction level decreased significantly by the end of a PBL in psychiatry course. To alleviate this issue, the PBL facilitators should play appropriate role at the preliminary phase of PBL implementation. This is particularly important for students who are new to new teaching approach like PBL. This claim is prevalent from the following comments:

- Misconception at the beginning, but later on can work on the task confidently by the guide of the facilitator (IR2_8).
- Feel very awkward at the beginning, but with the guidance of facilitator, I became familiar with the preceding tasks (IR2_5).
- "When I get entered into the class, during the first problem scenario, I´m totally unable to think about the learning issues. At first, I don't not feel good for the first tasks, but for the second and third tasks, I feel so ebullient, because I already knew....Because Dr Sopia (the facilitator) make it like multiple perspectives, not the subject matter one." (ES_7).

Originally, we are planning to give the groups complete autonomy to decide what they want to research on. However, they are actually asking for more direction, reassurance and help them narrow the scope of investigations. We should expect this since this is their first exposure to PBL. Hence we made our self available all the time while they are doing the discussions, and offered them to meet with beyond the class time.

5.1.2. Insufficient time

Time constraints are among the most prevalent issues raised by students. Comments like *´insufficient time´* are typical in students´ individual reflections while we are asking for the barrier in PBL learning. In addition, some students particularly stated in which stage of learning process that hey exhibited lack of time. Here are some written comments and interview extracts from students claimed that the time is insufficient to deal with the tasks, to do the discussions, to understand and to complete the tasks:

- "Not enough time to deal with task. However, it is worthwhile to invest such amount of time because this is the first PBL task for the course." (GR1_3).
- "I always feel guilty while doing the group work..because of the late submisison of the works. We do not have sufficient time to deal with the task and it is quite difficult for us to meet physically beyond the class time to do the discussions". (ES_5).
- Need more time for discussions. (IR2_1 and IR2_6).
- Big or higher level problem tasks required more time, at least need 2 sessions of discussions. (IR2_20).
- Insufficient time to complete the task. (IR2_22).
- "Sometime we expect that we can complete the tasks within 2 weeks, but actually we are unable complete it." (ES_2).

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

- Require more time and support to understand a specific PBL tasks. (IR2_7).

Time insufficiency is a recurring issues among the PBL groups. The following comments are extracted from group reflection and it occurs in all three PBL tasks:

For PBL1

- Not enough time to deal with task. However, it is worthwhile to invest such amount of time because this is the first PBL task for this course (GR1_3)
- For PBL2
- No (time is not sufficient), because there is a lot of readings that need to be done (GR1_1)
- For PBL3
- No, we need more time for discussions (GR1_6)
- No, we do not have enough time to deal with the task. We felt that we can do better if we can have a bit more time on the tasks (GR1_3).

To add further, some students justified why time is insufficient. The reason is related to cognitive ability of the learners in the student centred learning approach and geographical boundries:

- No experience to deal with the task, hence need more time to completed the assignments. (IR2_2)
- Limited time to discuss face by face with group members since all of them are part-timers and stay apart from the university. (IR2_24)

So and Kim (2009) echoed the finding by reporting that 20 students in their research see PBL as a time-consuming approach and require a lot of time in solving the problems/tasks.In Lai and Tang (1999) research, students also commented that the time allocate for them is limited and would prefer more lectures to tell them the ways to deal with the problem tasks in PBL.

5.2. Perceived benefits.

Students found PBL as satisfying and their percieved benefits of participations in the PBL were classified into two categories; Skills acquisitions, development and improvement; knowledge and and group processing.

5.2.1. Skills acquisitions, development and improvement

Students were well aware of the variety of skills they acquired throughout the course. Apparently, the common related skills were communication skills, skills to deal with the variety of resources, creative and active thinking skills, probing the questions:

- Enjoyed, get feedback from peers and improved communication skills (IR2_1).
- Encourage creative and innovative thinking, enhanced collaborative and self-directed learning skills, and increase motivation (IR2_19).
- Learn a lot even for only one PBL task, content and skills learned simultaneously, improved communications and develop presentations skills (IR2_6).
- Group collaborations, gained ideas from different people, searching for the resources from several perspectives, improved skills in dealing with a specific problem (IR2_2).
- Active learning environment, gained stimulate active and creative thinking skills, encourage students to discuss, evaluate, analyze, giving opinions and decision making. Also improved communication skills and flexibility in information processing (IR2_3).

These perceived skills acquisition, development and improvement s are consistent with fundamental aims that characterize PBL, which is to inculcate skills and competences. From the comments, it indicated that student learnt and used the skills through their engagement in PBL learning process (during discussions and resource findings). In addition, PBL is not only served to inculcate skills, but also hone the skills of the learners.

5.2.2. Group processing

Significant evidences were found about how students perceived benefits in the PBL class from the group processing point of view. From the analysis, students claimed that group processing in PBL serve as an opportunity for them to

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

validate arguments, and exchange and expand ideas which results in better resolutions towards tasks. Here are some of the related claimed:

- ”Sometime we are unsure whether what we understand is correct or not, so by getting the feedback from our group peers, we could validate our understanding..we will be more confident since we ger the feedback from our group members…become more confident about what we are suppose to learn in our class. Getting the feedback from our group members, we can know about our weakness.”(ES_5)
- Easier to deal with the task since it is group works, get different view from each group members, a more proper ways to complete a task, and inculcate innovation and creativity. (IR2_23)
- Students become more independent in solving the problems, increase the understanding of students due to the exchange of the ideas among group members, encouraged collaborations among students, the skills obtained in the class could be apply in the daily life. (IR2_27)
- “Learn more in group rather than learning individually, because we got much more ideas from our group members rather than merely having our own ideas in the individual studies. the ideas or the responses are varied and diverge, sometime it never across in my mind that learning issues could be develop in very good way, because I could only think about one aspect, but my friend could contribute ideas which is totally different aspects from mine, so we could accumulate variety of answers while learning in PBL. I learned many new things. compared to my previos education. In PBL, we are sharing the knowledge, that is so good to do.”(ES_7).

In addition, students relate the group process as the way to ease the burden in the tasks:

- “Stimulate to ask questions further and deeper, will get different kind of ideas, and can get better ideas, save a lot of time in learning since the burden is divided among the group members.” (ES_1).
- “When we get together during the group discussions, we can feel enjoy,we completed our works together..when we seat in a group, we do not feel the hardships that we feel when we seat alone.” (ES_2).

Students positive thoughts about teamwork and group learning process features like sharing knowledge ideas and resources reflect the effectiveness of PBL in developing and maintaining the group learning behaviours.

6. Summary

In designing a PBL learning environment, we are adopting the DBR framework to guide the whole process of the designs. The rationale of using DBR is the emphasis of contextual element in the design. The three PBL tasks were designed in a way that group of students can experience the interdisciplinary learning, enhance their generic skills and at the same time address the acquisition of content knowledge. We also specified the PBL learning to students to facilitate them throughout the course. To align the assessment with PBL, we emphasize on continuous, and formative assessment, with the significant weightage on group assessments. It is a certain that this PBL learning environment is far from perfect. Rooms of improvement from variety of perspective is always welcome. So in this paper, we eliciting students´ perceptions of their participation in the PBL class, particularly focus on issues and benefits. From data analysis, *initial anxiety and struggle* and *insufficient time* were two main issues raises by students. The results also suggest that facilitators could play significant roles by guiding and coaching to ease the anxiety and struggles of students during the early PBL tasks. In terms of time insufficiency, students specified that they have insufficient time during discussions, dealing and complete with the tasks, meet group members and in understanding PBL tasks itself. Students need time to accustom with PBL approach, especially if they are the novice learners in the active learning environment like PBL. For perceived benefits, we classified students response into two; *skills acquisitions, development and improvement and group processing.* Students see PBL as the way to acquire and hone their skills and value the process of group working to make reasoning on knowledge, and expansion of thoughts and ideas.

References

Achike, F. I. and Nain, N. (2005). Promoting problem-based learning (PBL) in nursing education: A Malaysian experience. *Nursing Education in Practice, 5*, 302-311.

Barman, A., Jaafar, R. and Naing, N. N. (2006). Perception of students about the Problem-based learning sessions conducted for medical and dental school' students of Universiti Sains Malaysia. *Education for Health, 19*(3), 363-368.

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., and Zech, L. (1998). Doing with understanding: Lessons from research on problem- and project-based learning. *Journal of the Learning Sciences, 7*(3–4), 271–311.

Barrows, H. S. (1996). Problem-Based Learning in Medicine and Beyond: A brief Overview. New Direction for Teaching and Learning, Jossey-Bass Publishers.

Casey, M. B. and Howson, P. (1993). Educating preservice students based on a problem-centred approach to teaching. *Journal of Teacher Education, 44*(5), 361-369.

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

Dean, C. (1998). *PBL and meeting the challenges of teacher education*. Retrieved January 30, 2012, from http://www.samford.edu/pubs/pbl/pblins1.pdf. .

Hmelo, C. E. and Evensen, D. H. (2000). Problem based learning: Gaining insights on learning interaction through multiple methods of inquiry. In, D. H. Evensen, & C. E. Hmelo (Eds.). *Problem-based learning: A research perspective on learning interaction.* New Jersey: Lawrence Erlbaum Associates.

Holgaard, J. E. and Kolmos, A. (2009). "Group or individual assessment in engineering, science and health education" in X.Y. Du et al. (eds.), *Research on PBL practices in engineering education*. Sense publishers, 57-69.

Holen, A. (2000). The PBL Group: Self reflection and feedback for improved learning and growth. *Medical Teacher, 22*(5), 485-488.

Hung, W., Jonassen, D. H., & Liu, R. (2008). Problem-based learning. In J. M. Spector, J. G. van Merriënboer, M. D., Merrill, & M. Driscoll (Eds.), Handbook of research on educational communications and technology (3rd ed., pp. 485-506). Mahwah, NJ: Erlbaum.

Kolmos, A., de Graff, E. and Du, X., (2009). *"PBL-Diversity in research questions and methodologies*" Research on PBL Practices in Engineering Education, Sense Publishers; Rotterdam.

Lai, P. and Tang, C. (1999). Constraints affecting the implementation of Problem-Based Learning (PBL) strategy in university courses. *Implementing Problem Based Learning Project. Proceedings of the First Asia Pacific Conference on Problem Based Learning* (pp. 193-200).

Lieux, E. M. (2001). A skeptic´s look at PBL. In *The Power of Problem-Based Learning: A Practical ´How To´for Teaching Undergraduate Courses in Any Discipline*. Edited by B. Duch, S.E. Grov, and D. E. Allen, pp. 223-235. Sterling, VA: Stylus Publishing.

Merseth, K. K. (1996). Cases and case methods in teacher education. In *Handbook of research on teacher education*, ed. J. Sikula, 722-44.2nd ed. New York: Macmillan.

Mohd-Yusof, K., Helmi, S., Jamaludin, M., Harun, N.. Cooperative Problem-Based Learning (CPBL): A Practical PBL Model for a Typical Course. International Journal of Emerging Technologies in Learning (iJET)**,** North America, 6, sep. 2011. Available at: http://online-journals.org/i-jet/article/view/1696. Date accessed: 24 Nov. 2011.

Mohd-Yusof, K., Tasir, Z., Harun, J. and Helmi, S. (2005). Promoting Problem-Based Learning (PBL) in engineering courses at the University Technology Malaysia. *Global Journal of Engineering Education, 9*(2), 175-183.

Murray-Harvey, R. Curtis, D. D., Cattley, G., and Slee, P. (2004). Enhancing learners´generic skills through Problem-Based Learning. Paper presented for the annual conference of the Australian Association for Research in Education, Melbourne, Australia. November 28-December 2, 2004.

Ryan, G. (1993). Student perceptions about self-directed learning in a professional course implementing problem -based learning. *Studies in Higher Education, 18*(1), 53-63.

Patton, M. (2002). *Qualitative research and evaluation methods*. Thousand Oaks: Sage Publications.

Peterson, R. F. and Treagust, D. F. (2001). A problem-based learning approach to science teacher preparation. *Models of Science Teacher Preparation*, 49-66.

Pereira, L. M. P., Telang, B. V., Butler, K. A., and Joseph, S. M. (1993). Preliminary evaluation of a new curriculum-incorporation of problem based learning (PBL) into the traditional format. *Medical Teacher, 15*(4), 351- 364.

Said, S. M., Adikan, F. R. M., Mekhlief, S. and Rahim, N. (2005). Implementation of problem based learning approach in the Department of Electrical Engineering, University of Malaya. *European Journal of Engineering Education, 3*(1), 129-136.

Seidman; I. (1998). *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences*. New York: Teachers College Press.

Schultz-Ross, R. A. and Kline, A. E. (1999). Using problem-based learning to teach forensic psychiatry. *Acad. Psychiatry,* 23, 37-41.

Schmidt, H. G. (1983). Problem-based learning: rationale and description. *Medical Education, 17*, 11-16.

Schmidt, H. G., Boshuizen, H. P. A., and de Vries, M. (1992). Comparing problem-based learning with conventional education: A review of the University of Limberg medical school experiment. *Ann. Commun.-Oriented Educ.*, 5, 193-198.

Strauss, A., and Corbin, J. (1990). Basic of qualitative research: Grounded theory procedures and techniques. Newbury Park, CA: Sage.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237-246.

Woods, D. (1994). Problem Based Learning: How to gain the most from PBL, Hamilton, Ontario.

Woods, D. F. (2003). ABC of learning and teaching in medicine: Problem based learning. *British Medical Journal, 326*, 328-330.

[a] Corresponding Author: Mohamad Termizi Borhan. Tel.: +06014-241-0321
E-mail address: termizi@fsmt.upsi.edu.my or borhan@plan.aau.dk

The Impact of the Implementation of the PBL for EFL Interdisciplinary Study in a Local Thai Context

Prarthana Coffin [a] *

[a] *UNESCO Chair in PBL,*
Department of Planning,Vestre Havepromenades 5,
Aalborg University, Aalborg-9000, Denmark

Abstract

Can Problem-Based Learning (PBL) principles and practices be applied to language education, especially within an academic writing course? The answer to this question remains ambivalent to many language teachers and educators. This study describes how PBL principles are used as the fundamental basis of restructuring English as a foreign language (EFL) writing course, called Writing3, at a Thai university. The study also examines students' and teachers' perceptions as related to their learning experiences. The case study involves 182 English major students and 3 English teachers who participated in learning and teaching of an EFL academic writing course (Writing 3) in the first semester of academic year of 2012. Pre and post survey questionnaires (N=166) are used and the results are analyzed through a paired samples t-test to compare whether there is a significant difference in students' perception towards the benefits gained in their learning experience from the PBL process. The focused benefits gained in this case are motivation in learning, communication skills, collaborative skills, critical thinking, problem-solving and self-directed learning skills. Furthermore, triangulation between teachers' perception towards students' learning which was obtained from questionnaires, interviews, and students' final grade, also confirm that the PBL process used with the Writing 3 course yielded a positive impact on both students' and teachers' learning experiences.

Keywords: Proble-Based Learning, language education, English as a foreign language (EFL), PBL syllabus design for a local context

1. Introduction

Implementing Problem-Based Learning (PBL) has widely spread across many different educational fields and across many different cultures and countries. The reasons most practitioners and scholars have given a similar answer is because a paradigm shift has occurred in education where learners are at the center of learning. The teaching environment and classroom dynamic must be active and PBL provides opportunities to achieve this. The implementation of PBL varies in form and level depending on local contexts. Whether PBL is incorporated at a component level or in the entire curriculum, they are grounded in the same principles: cognitive, content, and social learning (Graaff & Kolmos, 2007). This study is one of many examples that advocate the positive impact of PBL implementation in a challenging local context. After a long journey of cultivating relevant knowledge and experience in a form of design based research, the result of this case study is the final indicator to deliberate the impact of the PBL implantation with language education in a Thai context. The paper describes how the course syllabus is reconstructed in order to allow spaces of PBL practice with 182 English major students and three English teachers. This particular case study aims to answer the following major research question and two subsidiary research questions:

Main question: What is the impact of implementing PBL with EFL interdisciplinary study in a Thai university context?
Sub-question 1: What values and competences do the design and practice of PBL in EFL interdisciplinary study contribute to student learning outcomes?
Sub-question 2: What values do the practice of PBL organized studies contribute to the teachers' experience?

Prarthana Coffin. Tel.:+66 849482684
E-Mail: coffin@plan.aau.dk

2. Literature Review

2.1. PBL implementation in the field of English as foreign language learning (EFL)

The main purpose of teaching and learning a second and a foreign language has been shifted to assisting learners to achieve the communicative competence (Hymes, 1972; Canale &Swain 1980). Acquiring and achieving communicative competence means to be able to function or apply knowledge and skills beyond the classroom context and this requires knowledge, skills, and a positive attitude of learners. Recently, PBL has been implemented with the English as a second language (ESL) and English as foreign language (EFL) classrooms because of its common expected learning outcomes sync in with language learning: communication skills, collaborative and problem-solving skills, deep content learning and autonomous learning. Studies indicate that PBL aligns with language learning principles in which learners learn the target language by using it in a meaningful way to them. Previous studies of implementing PBL with ESL and EFL classes claim positive effects on both learners and teachers in terms of motivation, content learning, and practical skills (Mathews-Aydinli, 2007; Jiriyasin, 2011; Ng Chin Leng, 2009; Othman& Shah, 2007; Yusef, 2010). However, mostly the studies were conducted in a small scale which involved 10- 80 participants. There are a few bigger scales (over one hundred participants) of study in implementing PBL in an EFL context. Results of these studies also confirm the positive effects on both teachers' and students' learning experiences; however, it is also emphasized that a large scale of PBL implementation cannot be accomplished without encountering many obstacles (Forrester & Chau, 1999; Hallingger, Blackwood, & Tannathai, n.d.).

2.2. Design elements of PBL syllabus: in consideration of local contexts

As of present the implementation of PBL has been done in different disciplines, at different levels, in different countries or cultural contexts, and in different forms or modes. A variety of PBL implementation has been accepted due to the sensitivity of curriculum designers and researchers towards the diversity of the existing local cultures. This is because there is a belief that culture strongly influences curriculum design, teaching and learning practices. As many PBL experts all seem to agree that one form of PBL does not work with all contexts, but it must be modified and redesigned to suit each particular context (Kolmos, Graaff, & Du, 2009; Savin-Baden & Major, 2004; Barrett, 2005). As Savin-Baden and Major (2004) recommend that there are many elements and levels of the local cultural aspect to consider when implementing PBL (change), ranging from national, institutional, disciplinary, and individual cultures. Besides the cultural issue, an alignment between the philosophical principles underpinning PBL and four major elements of curriculum design (learning outcome, content and material, learning and teaching method, and assessment) must be considered when redesigning a PBL course or curriculum. These elements are taken into a serious thought and consideration in restructuring the PBL syllabus for Writing 3 course which offered in the first semester of the academic year 2012.

3. Restructuring an EFL Writing Course (Writing 3)

Individual writing activities have been preferred and popularly used as a part of teaching and learning writing for many years, especially in an EFL context. Writing 3 is compulsory for English major students at Mae Fah Luang University. In the previous semesters writing activities were individual based and focused on a final product, which was an academic paper. Though writing process has been used to foster students' learning, complaints from both teachers and students regarding the correlation of the final grade and learning process has continuously been the issue of concern. The aim of implementing PBL into this learning scenario is to at least minimize these concerns and further enhance students' academic knowledge and practical skills. As a result, the course syllabus of Writing 3 was redesigned based on alignments between the PBL principles, the local cultural context and the existing syllabus which including learning outcome, content and material, learning and teaching method, and assessment. Furthermore, in reconstructing the course, three major pillars (English communicative competence, PBL process, and discipline content) are placed in consideration for revising the new course objectives of the modified PBL semester module for the EFL Interdisciplinary Study. The PBL practice in this case is called embedding PBL into a research project. The following steps were applied in reconstructing the course.

1. Learning outcomes of PBL subjects and the research project must be first clarified.
2. Lectures should be interactive, supported by stimulus activities, and serve the research project.
3. Research themes must be open-ended and lead to innovative learning. The themes must be posed at the very beginning of the semester, by the PBL supervisor team.
4. Research topics and research questions must be within the premise of real-life problems, meaningful to learners, and relevant to the content of the PBL subjects. They must be formulated by students.
5. The research topics must allow multiple research methods and multiple findings.
6. PBL process requires feedback and deadline.
7. Students are also required to acquire peer and self- assessment skills by attending an intensive workshop and continue to practice peer and self assessment throughout the semester.

The following figure also illustrates the relevant elements to be considered when designing and implementing PBL.

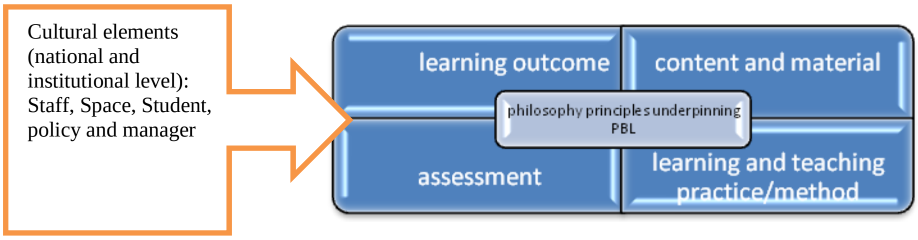

Figure 1. Elements influence the design of the PBL syllabus

The objectives of the course are reformulated based on the elements presented in figure1, details as follows:

1. Developing concepts of conducting a research project.
2. Practicing the research process by locating resources and efficiently utilizing the resources, formulating research questions, investigating the research topic and processing drafts and revisions of research papers.
3. Practicing the PBL process by contributing in collaborative learning, autonomous learning, peer and self-assessment in order to complete the research project.
4. Writing an effective abstract and an academic paper.
5. Developing editing skills.
6. Developing oral presentation and communication skills.

The new approach to learning Writing 3 also involves redistribution of the following elements of the course: content and learning activities, time allocation, and assessment. First, is the modification and redistribution of the course content, learning activities, and learning materials focusing on the process of academic writing rather than the product. In addition to the content of academic writing, PBL principles and processes are introduced to students in the form of workshops. Consequently, lecture time is reduced and is made to be interactive by emphasizing content discussion and knowledge sharing among learners. Before the lecture sessions, students are required to study materials so that they can question what they do not understand and share what they do understand during the sessions. Second, is the modification and redistribution of allocated time for different learning activities. The major change is that lecture time is minimized to 15 hours over a semester or 1/3 (total 45 hours) of total allocated contact hours, as compared to the previous course time which gave all 45 contact hours to lecture time alone. The remaining lecture time of the new approach was allocated to active hands-on workshops (12 hours) which require students to actively practice and share knowledge and skills. Furthermore, supervision time (18 hours) was also allocated and separated into two types. The first type is two formal seminar- supervisions which require every team and every section function in the same manner. Each formal seminar-supervision lasted about one hour per team and five percent of the total score was given based on the assigned rubric. The second type is informal meetings which are initiated by students, depending on the need of each team. Third, is the modification and redistribution of learning assessment. Forty percent of the total score is allocated to the PBL process which involves supervision and panel discussion (20%), PBL workshop (10%), and peer and self-assessment (10%). The other sixty percent is distributed to the academic writing products which involve written proposals (15%), two written drafts (35%), and a written abstract (10%). The figure below illustrates the redistributed time allocation of course activities throughout one semester.

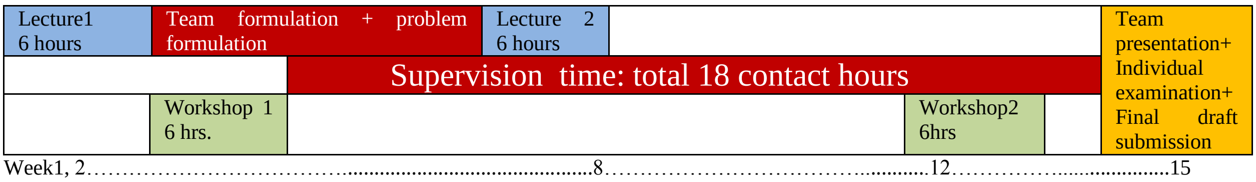

Figure 2. Activities and time allocation for the reconstructed course

4. Methodology

4.1. Participants and the setting

The newly designed PBL writing syllabus was implemented with 182 students and three teachers, including the researcher. The period of the implementation was June 2012- October 2012. However, collected data from pre and post surveys was from 166 students. Due twelve students were absent on the days pre-survey was administrated; therefore, post-survey was also collected only from those students who took pre-survey in June 2012. Furthermore, qualitative data was collected from two teachers via individual semi-structured interviews. It is noted that even though the researcher took part in facilitating the learning process, the interviewed data excluded the researcher for the purpose of subjectivity.

4.2. Instruments and procedure

For the purpose of validity of the assessments of the impact of implementing PBL semester module for the EFL Interdisciplinary Study in which embedding PBL into a research project, the use of triangulation information is central to this study. Therefore, instruments used for data collection for this case study consisted of the following:

1. Student questionnaire which consists of Likert scale survey in forms of pre and post surveys (25 items) and open-ended questions (5 items).
2. Teacher questionnaire which consists of 1) Likert scale (20 items); this part is for the teachers to assess students learning, and 2) open-ended questions for the teachers to reflect on the practice of PBL in their context (5 items).
3. Teacher interview in the form of an individual semi-structured interview
4. Students' grades (based on a scale of 100%, the range from A-F grades, were also used to assess students' performance in accordance to the objectives and the grading criteria of the course.

5. Findings and Analysis

The analysis of data from different sources is based on 1) A paired samples t-test to compare the results of pre and post surveys from students' self assessment (N=166); 2) content analysis is used with qualitative data; and 3) a summary of teachers' perception towards their students' learning from Linkert scale questionnaire and a summary of individual semi-structure interviews from two teachers; and 4) students' final grade. The findings and the analysis of each element are as follows:

5.1. Result of pre and post survey questionnaire from 25 items of student questionnaire

A paired samples t-test was conducted to compare the before and after self rating of students on: 1) the overall self assessment on the overall learning outcomes; 2) level of motivation; 3) level of collaboration; 4) level of PBL process in practice; 5) level of self-directed learning; 6) level of communication skills; 7) level of utilization of peer assessment; and 8) level of critical thinking skill.

Table1. Statistical result from Paired samples t-test

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	AVERPRE	3.3694	166	.58723	.04558
	AVERPOST	3.8484	166	.75289	.05844
Pair 2	MOTIPRE	3.3052	166	.61454	.04770
	MOTIPOST	3.7390	166	.69447	.05390
Pair 3	COLLPRE	3.4895	166	.62967	.04887
	COLLPOST	3.9111	166	.83258	.06462
Pair 4	PBLPRE	3.4596	166	.57145	.04435
	PBLPOST	3.9045	166	.70818	.05497
Pair 5	SDLPRE	3.4930	166	.66321	.05148
	SDLPOST	3.8323	166	.83252	.06462
Pair 6	COMPRE	2.7972	166	.77048	.05980
	COMPOST	3.7510	166	.84939	.06593
Pair 7	PEERPRE	3.3976	166	.71461	.05546
	PEERPOST	3.8855	166	.76406	.05930
Pair 8	PRE21	3.38	166	.701	.054
	POST21	3.91	166	.769	.060

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	AVERPRE - AVERPOST	-.4790	.78268	.06075	-.5990	-.3591	-7.886	165	.000
Pair 2	MOTIPRE - MOTIPOST	-.4337	.55106	.04277	-.5182	-.3493	-10.141	165	.000
Pair 3	COLLPRE - COLLPOST	-.4217	.87423	.06785	-.5557	-.2877	-6.215	165	.000
Pair 4	PBLPRE - PBLPOST	-.4449	.82124	.06374	-.5708	-.3191	-6.980	165	.000
Pair 5	SDLPRE - SDLPOST	-.3394	.82957	.06439	-.4665	-.2122	-5.271	165	.000
Pair 6	COMPRE - COMPOST	-.9538	1.06547	.08270	-1.1171	-.7905	-11.534	165	.000
Pair 7	PEERPRE - PEERPOST	-.4880	.97383	.07558	-.6372	-.3387	-6.456	165	.000
Pair 8	PRE21 - POST21	-.53	.977	.076	-.68	-.38	-6.994	165	.000

The statistical results of the SPSS can be interpreted and analyzed as follows:

1. Pair1 compares the average of all 25 items of pre-test (M=3.3694, SD=.58723) and post-test (M=3.8484, SD=.75289); t (165) = -7.886, p= .000 indicate that there is a significant difference between the overall result of the pre-test and the post-test.
2. Pair2 compares the average of the clustered motivation items (1, 14, 25). The result of pre-test (M=3.3052, SD=.61454) and post-test (M=3.7390, SD= .69447); t (165) = -10.141, p= .000 indicate that there is a significant difference between the pre-test and the post-test under the cluster of students' motivation. This means students' motivation in learning has increased after going through PBL process.
3. Pair3 compares the average of the clustered collaboration skill items (2, 4, 7, 12). The result of pre-test (M=3.4895, SD=.62967) and post-test (M=3.9111, SD=.83258); t(165) = -6.215, p= .000 indicate that there is a significant difference between the pre-test and the post-test under the cluster of collaboration skill. This means students' collaboration skill has increased after going through PBL process.
4. Pair4 compares the average of the clustered PBL process items (3, 5, 10, 19, 20, 21, 22). The result of pre-test (M=3.4596,SD=.57145) and post-test (M=3.9045, SD=.70818); t (165)= -6.980, p= .000 indicate that there is a significant difference between the pre-test and the post-test under the cluster of PBL process. This means PBL process is incorporated in teaching and learning of Writing3.
5. Pair5 compares the average of the clustered self-directed leaning skill items (6, 8, 9, 11, 13, 15). The result of pre-test (M= 3.4930, SD=.66321) and post-test (M=3.8323, SD=.83252);t (165)= -5.271,p= .000 indicate that there is a significant difference between the pre-test and the post-test under the cluster of self-directed learning skill. This means students' self-directed learning skill has increased after going through PBL process.
6. Pair6 compares the average of the clustered communication skill items (16, 17, 18). The result of pre-test (M=2.7972, SD=.77048) and post-test (M=3.7510,SD=.84939); t(165)= -11.534, p= .000 indicate that there is a significant difference between the pre-test and the post-test under the cluster of communication skill. This means students' communication skills have increased after going through PBL process.
7. Pair7 compares the average of the clustered peer and self-assessment items (23,24). The result of pre-test (M=3.3976, SD=.71461) and post-test (M=3.8855, SD=.76406); t (165) = -6.456, p= .000 indicate that there is a significant difference between the pre-test and the post-test under the cluster of peer and self-assessment. This means students have strongly taken part in peer and self-assessment, as stated in the course objective.
8. Pair8 compares students' critical thinking skill. The result of pre-test (M=3.38, SD=.701) and post-test (M=3.91, SD= .769); t (165) = -.6.994, p= .000 indicate that there is a significant difference between the pre-test and the post-test on students' critical thinking skill. This means students perceive that PBL process used with Writing3 course has encouraged and increased their critical thinking skill.

5.2. Result of teacher assessment on students' learning

The teachers' perception towards their students' learning development, rating Likert scale, can be summarized as follows.

1. Both teachers agreed that their "students have made progress in the development of collaborative skills and self-directed learning skills" once PBL process is incorporated into their teaching and learning contexts. This indicates that the PBL process has raised their motivation in learning through working on the research project collaboratively.
2. Both teachers also agreed that practicing PBL has helped their "students exhibit the development of their commutation skills which including both English writing and speaking or presentation skills."
3. Both teachers also agree that PBL implemented in their classroom contexts "has enhanced their students' (deep) learning content."

5.3. *Qualitative data from 2 teachers completed open-ended questionnaire questions (a reflection notes)*

The result from this part comes from the response to reflective questions by two English teachers. Item 1 asked teachers to give a description of PBL practice in their contexts. Teacher 1 stated that existing problems and potential problems were used as the first step to drive students' learning. Students were encouraged to be aware of those problems. Then students began to look for ways to deal with the problems by searching knowledge/information to help them cope with the problems. Along the way students learned new knowledge from the subject content itself (lectures) and from their working process. Consequently, they learned about themselves, as well as learning to solve the problems. Similarly teacher 2 stated that the focus of student research projects, which emphasized the PBL process, was on students' interests and collaboration. First, students were asked to think about a problem or a concern related to their context. Students chose team members on their own. Together they planned and went through the research process and the PBL process. Along the process, practical skills were practiced such as analytical thinking, problem-solving, reading, note taking, communication, collaboration, and evaluating information and their own learning. Item 2 asked teachers to share and point out challenges and difficulties that they or their students encountered during the implementation period. Teacher 1 expressed that her students were confused in the beginning. *"They did not have a clear direction in their learning and they seemed to be frustrated with managing ideas and information."* However, after a few meetings or consultations they began to be able to shape up their ideas and directions in learning *"by mid- semester, they seemed to be clear in their work and its process."* Teacher 2 responded that "*it is difficult to maintain and balance an appropriate role as a PBL supervisor; when not too control of students' work and when to step in. The second challenge was how to monitor students' work process in terms of being fair and equal in their team contribution. Lastly, time demands were a big issue because PBL process requires a lot of time. I realized that being a PBL facilitator requires more that the academic and the teaching skills."* The last item of the open-ended questionnaire asked teachers to share the best experience or the advantages of implementing PBL in their context. Teacher 1 expressed that *"I feel that students were proud of themselves after realizing that they can learn be themselves, tackled problems by themselves, and gained new knowledge by themselves."* She further pointed out that *"this approach allows students to see their own potentials and I also have learned new things from working alongside the students as well."* Teacher 2 also responded similarly on this item, as she stated that *"the best experience was that students got to maximize their learning. They learned through self-discovery and hands-on experience. It is a realistic learning approach and students learned to work with other. As a teacher, I also learned about strengths and weakness of each individual student."*

5.4. Result of teacher interviews

In the first semester of academic year 2012, these two interviewees fully participated in the PBL process used with Writing 3 course. The general description of how the PBL process started was that from the first week of the semester students started to formulate their thoughts and the topic of their interests. Lectures of needed content were given during week 1-8 along with 2 workshops which focused on PBL process and team management. In week 4-5 most teams must have team proposals in place. The supervisions began from week 5 on. There were 6 sections and every section followed the same protocol of learning and facilitating. Supervision sessions were essential in the context of the Writing 3 course. Two formal supervisions were mandatory where every member must take an active role in presenting their part and asking questions that were useful for their research projects. The interview data revealed that both English teachers have had sufficient teaching experience. The first teacher has eleven years of teaching experience and has been involved in project-based learning, but not exactly problem-based learning. The second teacher has twenty years of teaching experience and claimed that PBL principles have been used with some of her master students because the master project used research process to facilitate students' learning, but students worked individually. First, both teachers were asked to describe the essential characteristics and process of PBL. The first teacher stated that "*in my opinion, PBL must start with problem first. Students will learn from two channels which are from the content of the course and from their own experience."* In terms of team formulation, both teachers stated that their students chose their own team members based on common interests and personal friendships. Team size was in the range of 2- 6 members. As for the size of team the second teachers expressed that *"I prefer very small team because smaller is better in terms of team management and collaboration"*. In the next question, both teachers were asked to give opinions on advantages of PBL implementation in their context. They both agreed that PBL helps students learn content in a meaningful way to them because the topics of their study are from their own interests. Their practical skills have also improved in communication, collaboration, and autonomous learning, as one teacher stated that *"in PBL process students learn by themselves with guidelines"*. The third question then asked the teachers to give opinions on disadvantages of PBL implementation in their context. One teacher said that "Both teachers and students must be ready for the change, otherwise it can go wrong." Another teacher stated that "Group work, which is a part f PBL process, can result in free riders". The last question asked the teachers to give opinions on good characteristics of PBL supervisors. Both of them agreed that having academic quality and knowing your discipline is very important. In addition, PBL supervisors must be open-minded to problems and students. One teacher further stated that PBL facilitation is more than just going to the classroom and giving lectures, but being a PBL supervisor "requires devotion of time, effort and patience".

5.5. Result of students' final grade

Table2. The final grades of 182 students

Section	#Ss	A	B+	B	C+	C	D+	D	F	I	M
1 Prarthana	28	-	2	5	10	8	3	-	-	-	-
2 Prarthana	22	-	-	5	8	7	2	-	-	-	-
3 Jintana	31	-	3	6	9	8	3	1	-	-	1
4 Sasima	35	-	1	7	10	8	7	2	-	-	-
5 Jintana	34	-	10	5	6	9	2	2	-	-	-
6Sasima	32	-	-	4	11	8	6	2	0	1	-
Total	**182**	**0**	**16**	**32**	**54**	**48**	**23**	**7**	**0**	**1**	**1**

The result of the students' final grades reflects the effectiveness of students' learning to some extent. Grade distribution of each section shows result in the same direction. Grade distributions of the six sections indicate the consistency of the assessments used with the course's learning activities. The teachers of this course all agree and advocate that the overall grade distribution of this course reflects the actual quality of students' performance and product required by the course objectives. It is also assured that the grade distribution of the whole course which consists of six different sections reflects the actual performance of students at the same standard because these teachers are considered highly professional and are the strictest teachers in the department. How these teachers have worked together closely (collaborative teaching) on facilitating and assessing their students' learning throughout the semester also contribute to quality assurance of grading of this academic writing course.

5. Discussion and Conclusion

The overall result of this study indicates that implementing PBL with language education, particularly in an EFL setting, yields many benefits to both learners and teachers. The results from different sources, triangulation method, show that both teachers and students highly appreciate PBL process because it has helped them in discovering their learning potential and gaining values and benefits from concrete to abstract elements as learners. Students express that their motivation, knowledge and skills have tremendously improved. To support students' perspective, teachers also rate the satisfaction level on students' learning progress and performance high. It can be pointed out the obvious values gained in this case study are communication skills, including both oral and written, and both in their target language and native language (language benefit). Moreover, collaborative learning, self-directed learning, motivation and critical thinking skills are also obviously enhanced respectively. This can be claimed that implementing PBL in this context was quite successful in terms of enhancing the learning experiences of both students and teachers positively and effectively. Despite gained benefits, it is also acknowledged that PBL process has brought frustration and more hard work to both students and teachers. Though the majority of students appreciate the new approach to learning and have gained benefits in this case study, there is still a concern that some students may be left behind. Having a strategy ready in hand to deal with this situation is highly recommended. As for challenges of being PBL facilitators is that it requires so much more work and professionalism from the teachers; they must be actively involved in the learning process and perform beyond just giving lectures in front of the class. As PBL facilitators are put into new roles and in constant learning mode; therefore, having a mindset for changes and openness to changes in learning philosophy, roles of each agent, and educational goals are also huge challenges for teachers. The experience of assisting the whole process of PBL implementation in this case has confirmed that PBL with a suitable modification for each local context is viable alternative educational strategy to transform a passive learning environment into an active learning environment.

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References

Barrett, T. (2005). Understanding Problem-Based Learning. In T. Barret, I. Mac Labhrainn, & H. Fallon (Eds.). *Handbook of Enquiry & Problem Based Learning* (pp.13-25). Galway: CELT.

Canale, M. & Swain, M. (1980). Theoretical Base of Communicative Approaches to Second Language Teaching and Testing. *Applied Linguistics*, 1(1), 1-47.

Forrester, V. & Chau, J. (1999). Current Developments in Problem Based Learning within the Hong Kong Institute of Education. In J. Marsh (Ed.) *Implementing Problem Based Learning Project: Proceeding of the First Asia Pacific Conference on Problem Based Learning* (pp.201-208). Hong Kong: The University Grants Committee of Hong Kong, Teaching Development Project.

Hallinger, P., Blackwood, A., & Tannathai, P. (n.d). Implementing Problem-based Learning in Thai Higher Education: A case Study of Challenges and Strategies. Retrieved December 23, 2012 from http://philiphallinger.com/old-site/papers/pbl/PBL_Thailand.pdf

Hymes, D. (1972). On Communicative Competence. In J. B. Pride & J. Holmes (Eds.). *Sociolinguistics* (pp. 269-293). Harmondworth: Penguin.

Jiriyasin, T. (2011). Enlivening EFL Discussion Classroom with Problem-based Learning Approach. Retrieved November 17, 2012 from http://www.culi.chula.ac.th/e-journal/2011/tanisaya.pdf

Kolmos, A., Graff, E. de., & Du, X. (2009). PBL-Diversity in research questions and methodologies: Research on PBL practices in engineering education. Rotterdam: Sense Publishers.

Kolmos, A. & Graaff, E. de. (2007). Process of Changing to PBL. In E.Graaff & A. Kolmos (Eds.), *Management of Change: Implementation of Problem-Based and Project-Based in Engineering.* (pp.31-43). The Netherlands: Sense Publishers.

Larsson, J. (2001). *Problem-Based Learning: A possible approach to language education?* Retrieved December 10, 2012 from http://www.nada.kth.se/jla/docs/PBL.pdf

Mathews-Aydinli, J. (2007). Problem-Based Learning and Adult English Language Learners. Retrieved November 17, 2012 from http://www.cal.org/caela/esl_resources/briefs/Problem-based.pdf

Ng Chin Leong, P. (2009). The Power of Problem-based Learning (PBL) in the EFL classroom. *Polyglossia,16*, 42-48.

Othman, N. & Shah, M. I. A. (2007). Language Acquisition Using the Problem-Based Learning Approach. Retrieved November 20, 2012 from http://www.docstoc.com/docs/32316412/Language-Acquisition-Using-the-Problem-Based-Learning-Approach

Savin-Baden, M. & Major, C. H. (2004). *Foundation of Problem-based Learning*. New York: Open University Press.

Yusuf, F. N. (2010). Benefiting Problem-Based Learning to (Re) vitalize Students' Academic Writing. Retrieved November 23, 2012 from http://file.upi.edu/Direktori/FPBS/JUR._PEND._BAHASA_INGGRIS/197308162003121-FAZRI_NUR_YUSUF/Kumpulan_artikel--ppt/Paper_Problem-Based_Learning.pdf

Problem based learning for measured drawing in Bachelor of Science Architecture program, UKM

SUHANA JOHAR, MASTOR SURAT, ADI IRFAN CHE-ANI, NORNGAINY MOHD TAWIL, NIK LUKMAN NIK IBRAHIM
Department of Architecture, Faculty of Engineering and Built Environment
Universiti Kebangsaan Malaysia

Abstract

Problem Based Learning provides tasks based on challenging problems that involve the students' problem solving, decision making and investigative skills. It serves to teach content by presenting the students with a real-world challenge similar to one they might encounter when they practicing the discipline. The learning approach applied in one of the architecture design course is very much adopting the approach and techniques used in the PBL. This paper attempts to document and describe the teaching practice used in Land Survey, Building and Measured Drawing course, of the Department of Architecture, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM). The approach implemented to second year student, which expected to practice their basic knowledge thought in their first year. The approach of learning that takes place in the implementation much assist in students' performance and development. By letting them to plan their works and creativity in problem solving much increasing the ability of investigating, improving soft and interpersonal skills, and stimulates confidence in communication towards the society, witnessed through their result from reports and verbal presentation.

Key Words: Project Oriented Problem Based Learning, Land Survey and Measured Drawing

1. Introduction

This paper attempted to describe and to document one of the architectural design teaching courses used in the department of architecture, UKM. One of the offered subject which is the measured drawing and the project based learning is by assigning to identify and documented the historical evidence of the proposed projects. Two important components have been designed before the complete report is produce, which is the land survey report and the measured drawing report.

2. Problem based learning and the measured drawing

Problem Based Learning (PBL) has been referred as an innovative and powerful learning environments used today. Graff and Kolmos (2007) defined it as a learning philosophy and a set of learning principles. It is both a teaching method and an approach of curriculum, consists of carefully designed problems that challenge students to use problem solving techniques, promotes self-directed learning strategies, team participation skills, and disciplinary knowledge (Guerra & Kolmos, 2011). PBL serves to teach content by presenting the students with a real-world challenge similar to one they might encounter when they practicing the discipline. Teaching content through skills is one of the primary distinguishing features of PBL. Conventionally, facilitators introduce students via lecture and texts. After a specific amount of content is presented, students are tested on their understanding in a variety of ways. PBL, in contrast, is more inductive: students learn the content as they try to address a problem.

In the PBL approach of learning, 'problem' are typically in the form of "cases", it can be complex, real-world challenges common to the discipline being studied. There is no right or wrong answer; and always have a reasonable solutions based on application of knowledge and skills. The "solution" based on the ability to think critically, which refers to ability to analyse, synthesize, and evaluate information, as well as to apply that information appropriate to a given context.

Two PBL models commonly used in higher education are: project based learning and case based learning. Project based learning problems are defined from a badly structured situation and carried out as projects, which indicates that the problems are an integral part. Case based models are commonly used in medical education, psychology, social science or science education (Guerra & Kolmos, 2011).

For studio based course, the project based learning is much to work with the need and objectives of the studies. The approach applied to the second year students, which they have been expose with some basis courses component to this subject. As described in the course outline, the Land Survey, Building and Measured drawing (KKSB 2223) course covers on survey in planning, design and implementation of engineering projects, in such of using the basic surveying equipment. It introduced students to the research methods and documentation of various information about heritage building, either through measured drawings, interviews, visual, discoveries and etc. Hence, by assigning an on-site training with medium complexity problems is best applied for developing critical thinking and other self-achievement skills. While, the role of facilitators in this subject includes providing regular feedback and guidance from time to time with the students. By allowing the students to do presentation and open group discussion, boost up their confident and improving self-communication skills.

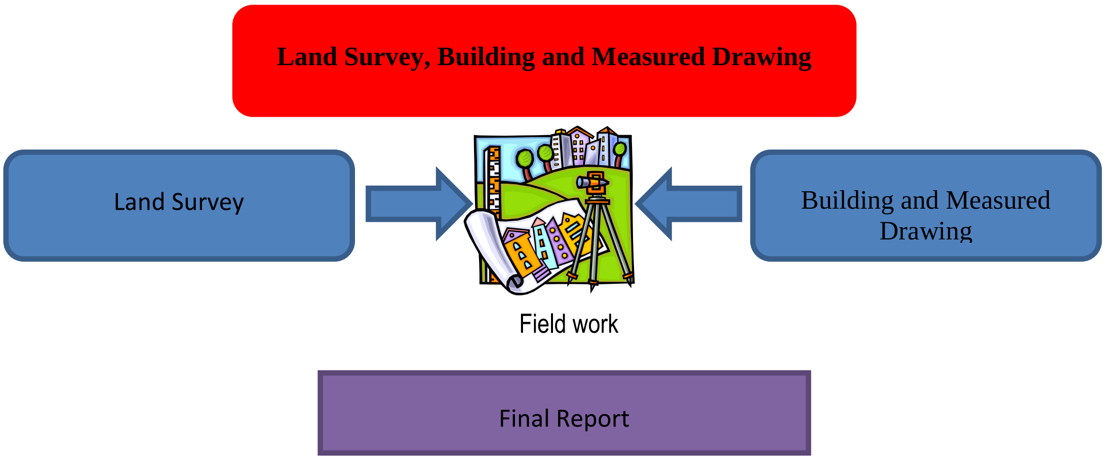

Figure 1. The approach learning for Measured Drawing course

3. The approach

The approach of teaching divided into two parts, the theoretical and practical. Theory is to provide basis and introduction of relevant subject, and practical provide knowledge by exposing students to real applications on site. Students are grouped into three and each group represents one of the case studies. Each group consists of 6 to 7 students are required to complete the land survey and measured drawing by producing final report of proposed site studies. Each site has its specific problems, and here students required to use their creativity and critical thinking ability in problem solving through what they have learned during their studies. Three main questions been developed; what is the significance of the buildings; how to and why land surveying to particular area; and how the building constructed. From these questions, student using their skills of investigation and it acts as a guiding response in their final report.

The proposed 3 sites are referring to two types of building typology, which is the traditional mosque and traditional vernacular house. Two of the buildings are a community mosque and one is an authentic traditional wooden house. The buildings are Masjid Qariah Ulu Beranang, Masjid Lama Kg. Mendun and Jainam's Residence (Rumah Jainam), and all located in Ulu beranang and Lenggeng, a border line to Negeri Sembilan. The students are required to record the topography details of the site studies and documented the historical background and elevations of the building as part of an archive. By giving different type of building typology, a variety of expected outcome and information should be gained.

The planning and timeframe have been designed to meet the learning sessions within 14 weeks. Based on this, there are third phase identified and this can be referred in the next sub chapter.

Photo 1. The Site Study (a) Rumah Jainam; (b) Masjid Lama Kg. Mendun; (c) Masjid Qariah Ulu Beranang (Mastor et. al, 2012, a, b, c)

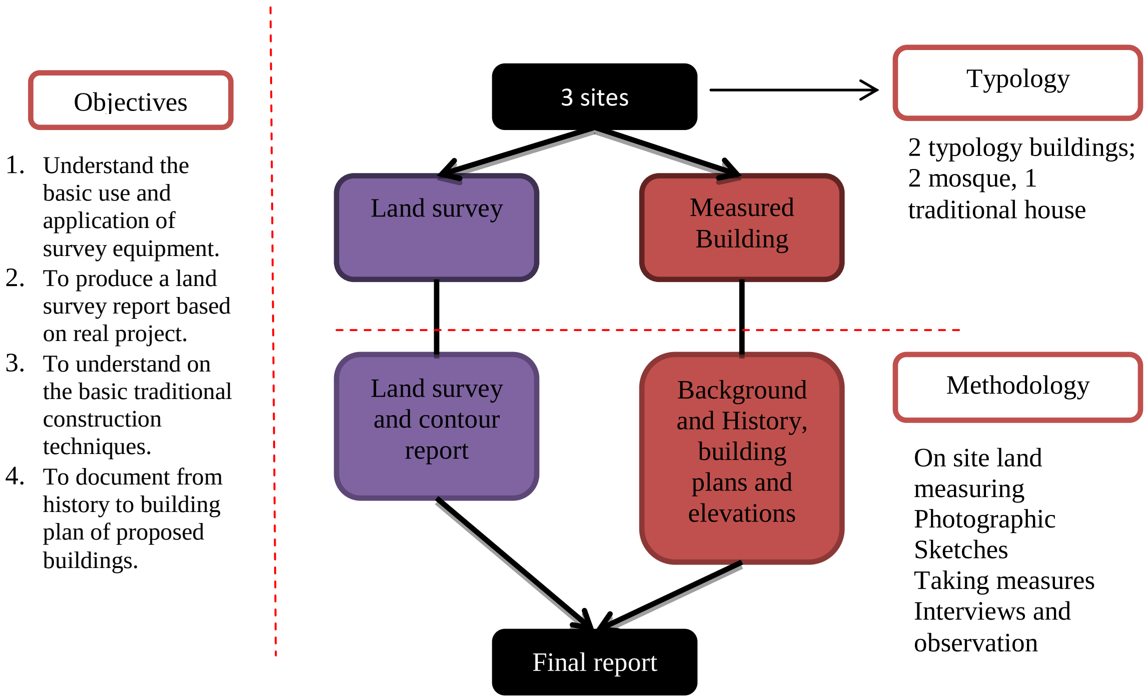

Figure 2. The Approach Assignments

4. The phase of work

Planning for 14 weeks, this project have been separated for three phases; the theoretical, the field work and the report preparation. For first 3-4 weeks, students have been thought for theoretical matters, which this including the theory parts of the land survey. Student must know the basic parts of land surveying works, the purpose and how its operate. For the Building and measured drawing part, an introductory lecture of the basic content of measured drawing including a session of discussion of the importance of conserving a heritage building in the built environments. Theoretically, students are equip with some basic content of the subject before a thorough content will be thought in the next phase.

Moving to the next phase, the field works purposely expose student with the site study. For the first stage, student assigned to prepare a contour plan of the proposed site. Each three group with different site will prepare the land survey works, identifying the boundary, obstacles or any contour level existed. After gathering the land survey data, students prepared to measure the building from top to the bottom, right and left in which to prepare the building elevation and layout. Basic equipment been used to measure the building and sketches been made to detail out every unique parts of the building. Obstacles may existed and this is where student will use creativity thinking and an on-site discussion made in solving problems.

An interview and survey session is part of the methodology use to find out the history and background of identified subjects. The respondents, which the building owner, the 'penghulu kampung' or from the old people or community that once know the history or detail parts of the buildings establishment. Some written history may also been documented from the previous scholar which this can be found from literature, books, and digital media.

Once everything has been gathered, all the data will then processed. From sketches, a digital drawing will be produce, from raw interview details to a history report will be made and validate the accuracy of the history. Also from the land survey works, a detail contour plan is made. From here, the student practices of all the theories and develop of analysis thinking from what they learn. The production took place in the studio where there will be also a group of discussion issues on related problems.

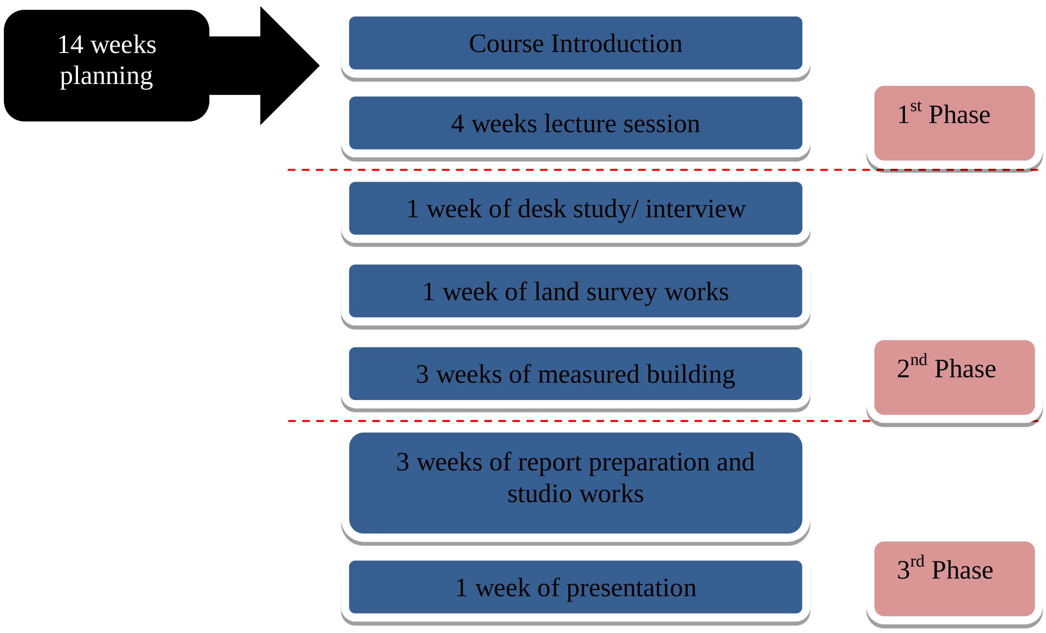

Figure 3. The Phase of Works

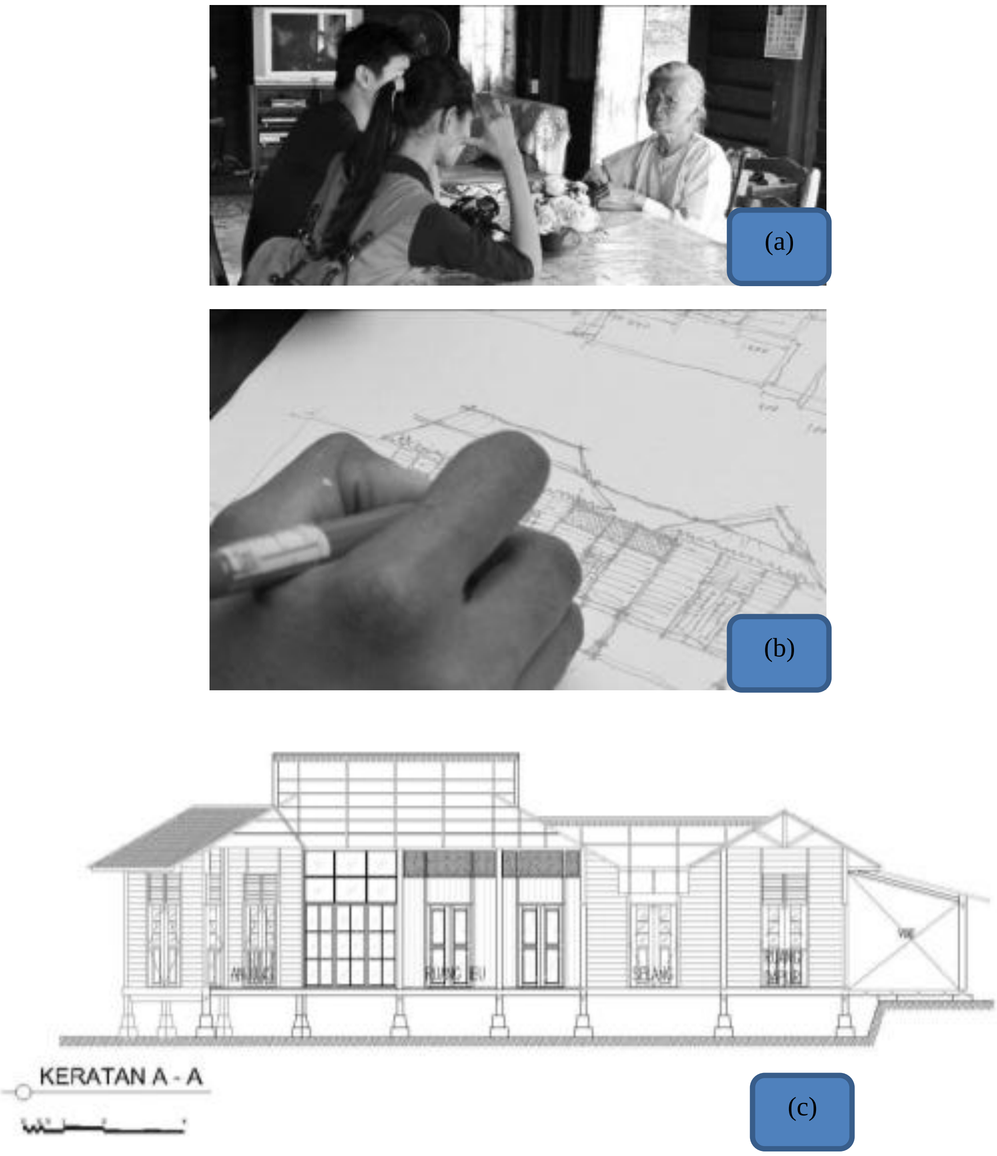

Photo 2.
(a) The Interview Session; (b) Sketching the Building Elevation; (c) CAD Drawing of the Measured Building (Mastor et. al, 2012, a, b, c)

5. The assessment

Each of the projects is assessed into two parts, the land survey parts and the measured drawing. To land surveying part, the distribution marks are based to three aspects which is the preparation of final surveying report, the accuracy of calculation and site analysis, and contribution for teamwork. Whereas for the measured drawings, the breakdown of the scoring given to the preparation of report and presentation, sketching and building drawings, historical reports, as well as teamwork among the group members. Both assignments carries 100% for their total marks, and for final, the land survey part contribute 50% and while another 50% are from measured drawing final report.

Group	Teamwork (10%)	Plotting accuracy/ analysis (50%)	Report Writing (40%)	Total marks (100%)
Group 1				
Group 2				
Group 3				

Group	History and Information accuracy (30%)	Sketching and drawing (30%)	Communication and teamwork (10%)	Report Writing and presentation (30%)	Total marks (100%)
Group 1					
Group 2					
Group 3					

Figure 4. The Assessment Sheet for Land Survey and Measured Building Assignment (Mastor et. al, 2012, a, b, c)

In Problem Based Learning, students are given the responsibilities and opportunity to manage and planning their work task and creativity to gained information. The lecturers are focussed on monitoring students' progress as well as facilitate them through group discussion when needed. The final report which represent their originality of work are to be kept for archive for further research purpose and publication.

6. Findings

The approach of learning that takes place in the implementation much assist in students' performance and development. By letting them to plan their works and creativity in problem solving much increasing the ability of investigating, improving soft and interpersonal skills, and stimulates confidence in communication towards the society, witnessed through their result from reports and verbal presentation.

7. Conclusion

The approach of Project based learning towards one of the architectural course help much in teaching materials. Comparatively with conventional way, students exposed to real site projects which enhance much ability and skills in problem solving. The preliminary exposure to real onsite studies not only to cater the goal of learning outcome, but also giving extra credit in soft skills development through socializing with the community, that being one of the requirement in completing this task.

Reference

Gallow, D. (2000). *What is Problem-Based Learning?* . Retrieved February, 2013, from Problem-Based Learning Faculty Institute: http://www.pbl.uci.edu/whatispbl.html

Graaff, E., & Kolmos, A. (2007). *Management of change implementation of problem-based and project-based learning in engineering.* Netherlands: Sense Publishers.

Guerra, A., & Kolmos , A. (2011). COMPARING PROBLEM BASED LEARNING MODELS: SUGGESTIONS FOR THEIR IMPLEMENTATION. *PBL Across the disciplines: research into best practic,e 3rd International Research Symposium on PBL 2011,* (pp. 3-14). United Kingdom: Coventry University.

Sharif, R., Maarof , S., & Meor Razali , M. (2012). PROJECT ORIENTED PROBLEM BASED LEARNING IN ARCHITECTURE DESIGN STUDIO IN BACHELOR OF ARCHITECTURE PROGRAM, UPM . *The Proceedings of Malaysian Architectural Education Conference 2012* , (pp. 65-75). Kuala Lumpur.

Surat, M., Mahmud, A., & Johar, S. (2012 a). Laporan Ukur Tanah, Bangunan dan Lukisan Terukur, Masjid Lama Ulu Beranang. Bangi: UKM.

Surat, M., Mahmud, A., & Johar, S. (2012 b). laporan Ukur Tanah, Bangunan dan Lukisan Terukur, Rumah Jainam. Bangi: UKM.

Surat, M., Mahmud, A., & Johar, S. (2012 c). Laporan Ukur Tanah, Bangunan dan Lukisan Terukur: Masjid Kampung Mendun. Bangi: UKM.

From (the most) effective learning to more useful research? Problem-based learning, collaborative 'complex problem-solving', and outcomes-based interdisciplinary inquiry

Cameron Richards

SUSTiP Research Group, UTM International Campus, Jalan Semarak, Kuala Lumpur, Malaysia 54100

Abstract

Learning models of applied problem-solving are an important key to transforming education so that graduates develop better skills, knowledge and attitudes to tackle the increasingly complex challenges which face fast-changing social and natural worlds. Universities should also prepare learners to more effectively practise related authentic problem-solving skills, knowledge, and attitudes which can or should be practiced in terms of both concrete and abstract forms of outcomes-based knowledge construction. This is especially so in terms of how the kind of systems model needed to address complex problems in nature and society presupposes the benefits as well as requirements of interdisciplinary inquiry or research for integrated, optimal, and sustainable solutions. To this end the paper will explore how the most effective problem-based learning might also represent a systems view of problem-solving and wider notion of outcomes-based knowledge-building.

Keywords: problem-based learning, complex problem-solving, outcomes learning and research; interdisciplinary knowledge-building

1. Introduction

Once described as a *foundation* or *linear structure*, knowledge today is depicted as a *network* or a *web* with multiple nodes of connection, and a *dynamic system* – Julie Thompson Klein, *Interdisciplinarity and complexity*, p.2

In the 21st Century in a fast-changing, complex and often difficult world of endless challenges and accelerating crises people have to increasingly deal with what Kolko (2011) and others call 'wicked problems' – that is, problems without any simple solutions requiring greater collaboration and the linking of different areas or disciplines of knowledge. In this way it is no longer good enough for universities to merely reproduce knowledge as merely surface learning or descriptive research (Trilling & Fadel, 2009). Problem-solving is the basic human impulse to actively engage in changing and improving human knowledge in the adaptation to changing global as well as local contexts of relevance and importance (Armstrong, 2012). On one hand this may involve science and technology responses to increasingly complex adaptations to physical environments. On the other hand, from a rather a human or social science perspective this may also involve social, political and economic as well as cultural contexts of communities, organisations and whole societies trying to balance internal imperatives and external challenges as well. Philosophers such as Karl Popper and Bertrand Russell have long stressed the sophisticated ways in which problem-solving can or should be linked to the thinking process. However, as Socrates (whose elenchus method was a prototype for modern scientific methodologies) long ago pointed out, a problem-solving approach to thinking is one which is potentially open to anyone (or any learner) to negotiate the implications and omissions of the perpetual gaps between human knowledge and ignorance (Paul & Elder, 2004). In short, any kind of human problem-solving process is also inevitably a learning process – a key reason why formal education can be so readily and effectively enhanced by problem-based learning approaches.

Problem-based learning (PBL) is a developing movement in international universities with interdisciplinary as well as specialist implications for a diverse range of disciplines and knowledge areas besides the medical schools where it originated as a formal method of using authentic cases (Barrows & Tamblyn, 1980). As a concept the term has been further adapted as a generic approach to active or constructivist approaches to learning in schools as well as universities (e.g. Jonassen et al, 2003). In this way it has been linked to related notions of self-directed outcomes (Biggs & Tan, 2011), critical thinking or inquiry (Paul &

Elder, 2004), and also notions of collaborative or social learning (Wenger, 1999). However we believe it is most useful to consider how problem-based learning exemplifies what many call 'higher-order' and others 'deep-level' notions of learning applicable to practical as well as conceptual or theoretical domains in contrast to the lower or surface notions of learning as the mere transmission, reproduction or even imitation of content in the form of information or basic skills (Bailley, Hughes & Moore, 2003). In this way as a model of active or constructivist learning and knowledge inquiry, PBL has long also exemplified the challenges and resistances to traditional educational models of an exam-based curriculum and a teacher-centred pedagogy as well as curriculum (Hmelo-Silver, 2004).

In this paper we discuss a systems approach to problem-solving in general as well as to problem-based learning in particular. In terms of how PBL exemplifies the possible links between formal education and the pivotal human capacity for problem-solving, we further discuss how this also presupposes a related systems approach to better integrating methods or designs of pedagogy, curriculum and assessment as well as the learning process. The discussion below will be organised around two related sections. The first section will look at the link between PBL and a systems view of the distinction between simple and complex problem-solving. The second section will use a practical example to discuss how PBL might be recognised and applied as one of three central pillars of 'active learning' in terms of an integrated application also to curriculum design, assessment methods and learning process. It will do so in relation to how the particular subject provide a focus for also a design research and outcomes as well as evidence based approach to 'complex problem-solving' research.

2. The implications for PBL of a systems view of the distinction between simple and complex problem-solving

Deriving in particular from Van Bertalanffy's (1974) model of general systems theory, various related models of systems thinking or science share in common an interdisciplinary approach to or perspective on the link between different areas of knowledge. Most significant is how such theories or models are not only typically seen as applicable to both natural and human or social realms of knowledge but a means of linking what Bateson (1979) called the 'the necessary unity… mind and nature'. Thus an emerging paradigm of 'complex adaptive systems' (and related models of complexity theory) has encompassed notions of homeostasis, feedback and emergence in natural systems of physical matter, chemistry, and biology (e.g. Laszlo, 1972, Prigogine & Stengers, 1984, Mandlebrot & Hudson, 2005) on one hand, and on the other corresponding notions of life cycles, supply chains and change dynamics in various forms of human organisation involving complex social, economic and cultural imperatives (e.g. Forrester, 1991; Barratt, 2006). The related importance then of multi-disciplinary collaboration and interdisciplinary problem-solving (Klein, 2006) to complement rather than oppose content knowledge specialisation is thus reflected by how human organizations also function as naturally complex adaptive systems of energy and information in relation to changing environments (e.g., Mitleton-Kelly, 2003). In other words there is a natural connection between systems theory and the inevitably interdisciplinary requirements of complex problem-solving in and across all areas of human knowledge.

Scientific and other models of knowledge are often viewed in terms of mere data and information accumulation but the human capacities for observation and reflection as well as experimentation in relation to new or changing contexts are clearly more effective when framed as focused problem-solving of some kind. This is so in relation to how a problem is perhaps most usefully defined as a 'perceived gap between the existing state and a desired state, or a deviation from a norm, standard or status quo" (www.businessdictionary.com). A systems approach or perspective allows recognition that all human problems either directly or indirectly involve systemic complexity – even apparently simple problems. In contrast to both traditional mythology or superstition and various forms of typically de-contextualised or modern modes of positivism, reductionism and 'either-or' thinking, systems theory focuses on the interdependent as well as independent relation of wholes and parts in and across distinct systems in terms of the processes of interaction, change and transformation. As we have put it elsewhere (Richards, 2013, p.6):

Simple problems (e.g. a bacterial infection, a clogged up fuel filter, or a personality clash within a business organization) which may initially seem more serious and complex might well be quickly addressed and efficiently resolved. However good doctors, mechanics, and leaders all know that both simple and complex problems are all ultimately about restoring the natural and deep-level efficiency or health of a particular 'system' whether this be a patient, a car or a business organization. As the wicked problem concept illustrates, the world of actual human experience and organization as well as all nature generally is ultimately and intrinsically complex, interdependent, and open to perpetual change. Superficially 'simple' problems ever conceal a latent complexity, yet ostensibly 'complex' problems are ultimately quite simple in principle.

Figure 1 outlines a systems model of complex problem solving. It represents the three basic stages of addressing a complicated, difficult, and even an apparently impossible problem or challenge. Assuming that it has been established that we are dealing with a systemic or complex and not just superficial challenge or minor issue, the foundation stage then is to recognize and prioritize the various aspects of an identifiable problem of some kind. This main aim at this stage is to identity the key factors which might include both internal and external aspects, factors or 'variables'. The second stage involves investigating and coming up with possible distinct remedies to each of the main contributing factors, as well as some macro remedies to the main problem. The third stage then is to consider an overall formula which makes use of also distinct 'contributing solutions' but also considers these might combine together in a strategic way to be part of an overall solution. As well as combinations of parts in space any overall solution must also incorporate the process of time to anticipate obstacles to any plan as well as productive interventions and requirements of implementation. The three stages reflect the hermeneutic arc of an initial situation or 'naïve' awareness giving way to critical or explanatory deconstruction then followed by an applied stage of synthesis, reconstruction, or transformation (Ricoeur, 1994).

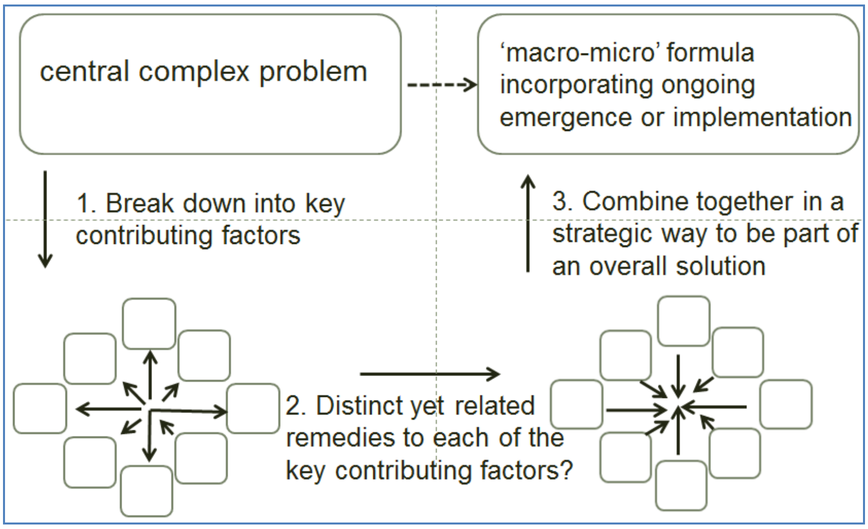

Figure 1. A systems model of complex problem solving

Figure 2 below further outlines an example of emergent *outcomes-based* rather than retrospective or rationalist *evidence-based* inquiry and problem-solving. It adopts the constructive version of the 'law of three' to outline a practical example of formulating a framework for addressing 'wicked problems'. The initial phase involves achieving a provisional or working foundation. On this basis a second stage seeks to prioritise the various relevant internal and external factors or contributing problems. Following on from or simultaneous to this, a third phase seeks to develop an emergent and convergent solution. The implied strategy then is to 'optimise' the problem-solving process in terms of transforming any relevant data and information into applied knowledge and understanding. As the right-hand diagram illustrates, an integrated, optimal and sustainable approach to addressing a central or focus problem can be designed in terms of a knowledge-building structure which establishes a relevant foundation, is able to progressively prioritise related issues, and further facilitates not only the acquisition of data and information but its transformation into useful knowledge.

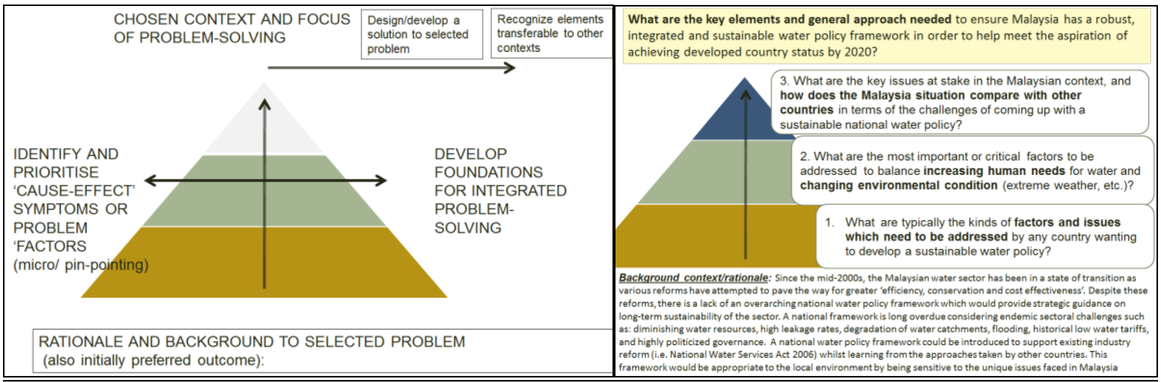

Figure 2. *A knowledge-building approach to the challenge of complex problem-solving*

This might be appreciated in terms of recognising the interplay of internal and external axes of inquiry which together constitute the so-called *data-information-knowledge-wisdom pyramid* (see Figure 3) used in such areas as 'management information systems' (e.g. Fricke, 2009). In such applications 'wisdom' is typically seen as unknowable or referred to only ironically. The accumulation and description tendencies of an external axis of empirical data and organised/rationalized information is redeemed or open to be transformed in terms of some focus outcome in relation to an internal axis of knowledge, experience, and understanding. In this way 'wisdom' need not be an accidental by-product or outcome of accumulation and complexity but actually a deep foundational process based on the quality of experience and understanding not quantity of information (Richards, 2011).

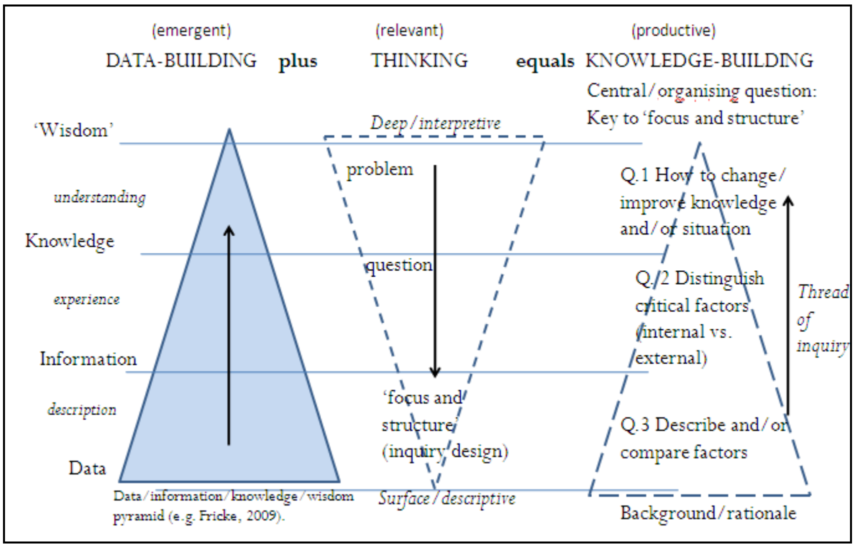

Figure 3. Thinking for problem-solving - the basis for transforming emergent data-building into productive knowledge-building. Adapted from Richards, 2012b

Figure 4 outlines a model for a paradigm shift from the linear and hierarchical assumptions of transmission and related reproductive learning models which tend to focus on the surface acquisition of skills or information. It further projects how an outcomes-based education approach aims to encourage deep learning outcomes associated with active or constructivist learning models (Spady, 1993). Whereas conventional learning outcomes ultimately represent a merely hopeful anticipation of the future often inadequately supported as an actual process of emergent knowledge building, an outcomes-based education approach works backwards from concrete notions of proficient and transferable performance in specific contexts to emphasize the crucial elements of pedagogical, curriculum and assessment design to support this as an actual process of emergent knowledge building. In this way we find it useful to make the distinction between conventional 'learning objectives' curriculum design and teaching on one hand, and on the other a truly 'outcomes-based' approach. This may be explained in terms of a related distinction between golf hackers who aim for the flag in a merely hopeful way and those try to align their game with a visualization of the required length, direction and trajectory for the ball to 'go in the hole' (Gallwey, 2009). For outcomes-based education to work properly, learning activities need to be sufficiently aligned in practice with the process not just metrics of assessment or evaluation. Likewise the formative aspects of the assessment as well as learning process need to be sufficiently encouraged and also aligned with the rationale and framework of summative assessment procedures. This is why project work and other 'culminating' modes of learning activity are so useful in facilitating more systemic or deeper modes of learning.

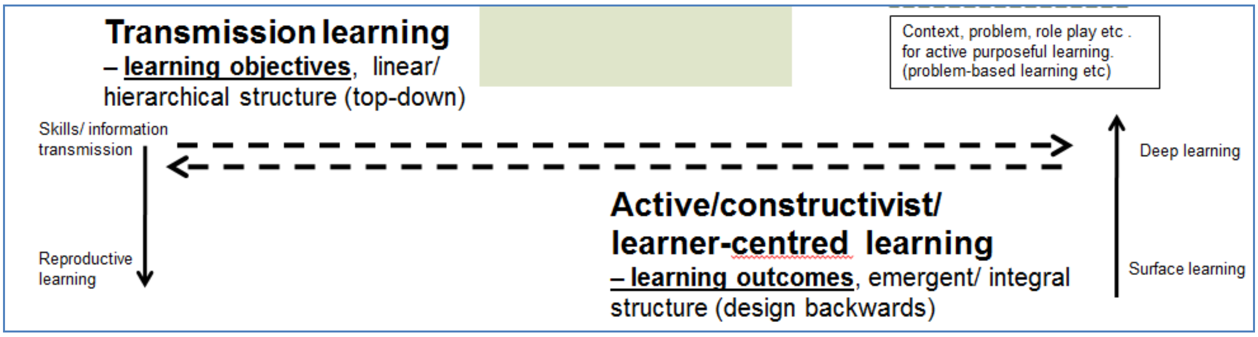

Figure 4. How outcomes-based education should 'reverse' not reinforce conventional and surface modes of transmission learning

As indicated above, active or constructivist learning models generally emphasize the associated alignment of related axes of critical thinking and applied performance on one hand, and on the other various complementary notions of surface and deep learning. This is why exams may well remain a useful part of an integrated assessment strategy and should not be seen in an either-or relation to project work, assignments, and related modes lending themselves to encouraging active or constructivist learning. We have also elsewhere argued that related models of problem-based learning, inquiry-based learning and project-based learning represent the three key pillars of the various permutations of active or constructivist learning (Richards 2004). This is on the basis of not only how such models correspond to the elements and stages of Kolb's (and also Schon's) learning cycle but also in relation to how problems, questions and tasks framed in authentic or imaginary contexts of learning activity lend themselves to a related alignment between formative and summative assessment as well as of surface and deep aspects of the learning process. Notions of surface learning are typically associated with the reproduction of information or skills where as deep learning is a mode of optimal performance or applied understanding transferable across different contexts (e.g. Biggs & Tan, 2011). Figure 5 thus depicts how a culminating learning task or activity provides the focus and structure for developing a 'knowledge ecology' foundation for optimal and sustainable learning application or performance.

As indicated earlier there are different applications of PBL in different areas of knowledge or for distinct outcomes. Some versions of PBL are promoted in terms of specific cases involving specialised knowledge (e.g. the use of PBL cases in medical education) whereas as others espouse interdisciplinary or 'across-the-curriculum' collaborative learning (Jonassen, et al, 2003). However either directly or indirectly PBL designs or approaches can most effectively enhance learning where some form of 'problem-solving' is linked to an alignment of focused outcomes and meaningful culminating activity. As Kolb (1984) suggests, the most effective cycle of learning involves active experimentation linked to concrete experience as well as to related processes and stages of reflective observation and abstract conceptualisation. In this way PBL can and should replicate the practical problem-solving experimentation of natural scientists as well as the thought experiments of the human and social sciences. In other words, the most effective PBL is typically conceived in terms of either authentic or imaginary 'problems' framed in variety of ways including cases, scenarios, questions, challenges, issues, and so on.

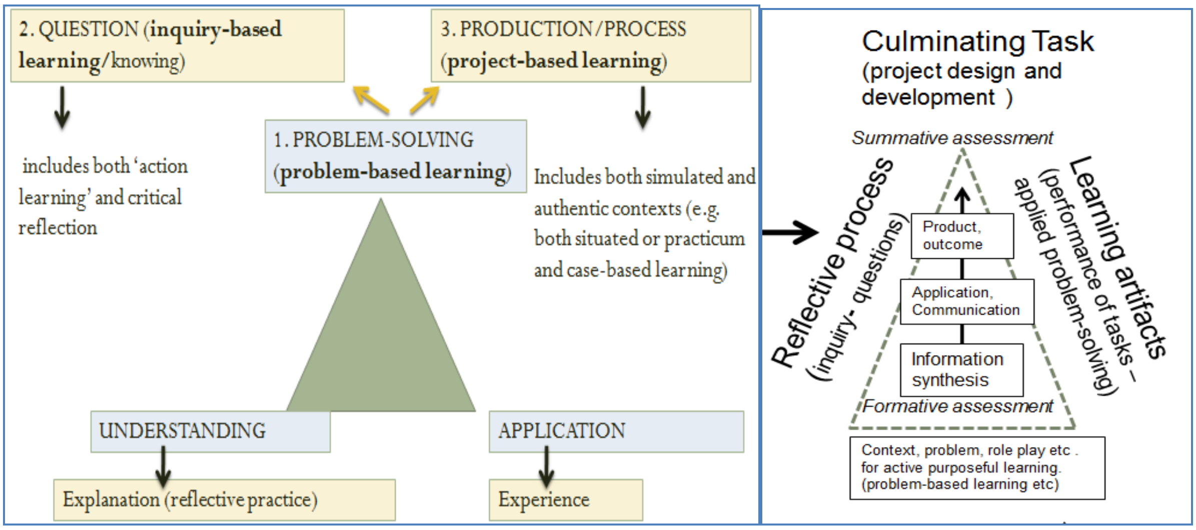

Figure 5. The three pillars of active or constructivist learning translated into an emergent learning-assessment framework

As Biggs & Tan (2011) outline, outcomes-based learning and assessment should link to provide a supporting framework designed to assist learners to achieve specific learning outcomes aligned with various activities and processes of active or constructivist learning. Inadequate applications of the outcomes-based education model tend to merely confuse outcomes with objectives and also ignore how there should be a crucial as well as constructive alignment of meaningful and effective outcomes with not only learning activities and processes but the formative as well as summative process of assessment. The conventional view of lesson-planning, syllabus design, and curriculum development has tended to emphasize linear and hierarchical content-focused models of skills or information acquisition. But active learning models rather emphasize the importance of interesting and engaging introductory contexts which also link to a process of knowledge synthesis and application in examples – emphasizing the importance of an integrated process of learning which also links reflection and activity. Thus a systems view and application of outcomes-based education should promote assessment *for* and not just *of* learning. It should also provide an integrated and structured educational but also inquiry 'space' (and not just classroom 'environment') for the emergent of effective learning as both understanding and explanation in terms of an effective linking also of macro level concepts, attitudes and general knowledge together with more micro level skills, content and detailed modes of knowledge. Good teaching and curriculum design should promote and encourage deep and not just surface learning transferable to other contexts. A systems approach, then, is useful in promoting deep learning.

3. Wicked problems and policy-builders of the future? Curriculum and assessment designs to support authentic problem-based learning for authentic policy challenges of sustainability

PBL has been particularly discussed above in terms of its application to promote assessment *for* and not just *of* learning. Various kind of authentic or imaginary learning 'problems' can either directly or indirectly encourage and support an associated mode of effective outcomes-based learning. We discuss below a recent example where we had the opportunity to apply a systems approach to teaching, curriculum and assessment within a completely new course. The module *MFT1053 Sustainable STI Policy Development* was unexpectedly added at the last moment to the initial 2012 offering of a new Masters program (Richards, in press). Short notice was received to conceive and develop this. However it was clearly a course which lent itself to a PBL approach with its focus on the challenge of sustainable policy studies linked to the similarly important concept of 'science, technology and innovation' (e.g. Christensen, 1997, Meissner, Gokhberg, & Sokolov, 2013).

We will discuss below three aspects of how we applied a PBL framework relevant for this particular course in relation to a similarly 'systems approach' to encouraging an authentic problem-solving orientation for authentic purposes linked relevant or possible cases, challenges, and issues which students could choose to focus on. The first section will outline how students were required to undertake a course project in pairs where they needed to identify, address and design a possible working solution to some distinct and authentic problem related to issues of sustainability also linked to aspects of science, technology and innovation. The second section will discuss how this encouraged and framed in relation to a digital portfolio assessment also involving related reflections and activities done individually to reflect, support and link to the culminating project and the related achievement of projected course outcomes. This involved an innovative yet effective assessment framework applied as a mark-sheet which, for space reasons, could not be included here. A third section indicates one of many conceptual tools used in this class which epitomises an outcome-based approach to 'integrated, optimal and sustainable' complex problem-solving.

3.1. Designing a problem-based learning project task in sustainable STI studies

The integrated program of teaching, curriculum and assessment in this course was built around the student development of a project involving a relevant focus problem. The classes of MFT1053 were conducted as a set of regular presentations linked to related tutorials. In addition to weekly presentations on course topics, each week students were required to individually present seminars on a topical new case of a policy problem from the local newspapers where they asked to identify interesting and exemplary STI-related policy problems of sustainability and also came up with initial suggestions of possible solutions. These presentations then were linked to tutor-lead discussion, and online as well as face-to-face class activities. For their presentations as for their main project, students were expected to produce a 'knowledge-building pyramid' which consisted of the translation of their chosen policy problem into an inquiry rationale as the basis for also identifying and engaging with a central question in terms of three supporting questions which might structure the inquiry towards emergent solution options. This regular linking of practical, interesting and authentic cases to aspects of theory, evaluation and the construction of design solutions became the foundation for students to later take on a more developed project which functioned as a culminating task synthesizing the stages and aspects of sustainable policy development as complex problem-solving in this particular subject.

Figure 6 below outlines how students were provided with options and supporting templates to support the development of their project inquiry in terms of three stages and corresponding parts of their required project write-up: (a) identify a brief rationale, background and supporting inquiry structure to address the selected policy issue or challenge; (b) critically break down central problem of selected policy issue into main contributing aspects, elements and factors, and (c) design and outline a proposed sustainable solution which would simultaneously address contributing challenge and central problem. The PBL project was expected to build upon the course foundations of 'sustainable STI' knowledge, case studies, and applied problem-solving. In this way it should represent a culminating activity of the overall course encouraging students to synthesise and apply what they have learnt so far in terms of projected key course outcomes.

MFT1053 Sustainable STI Policy Development

Project - STI Case Study in sustainable policy-building 40%

Class topics and activities will aid with the skills, knowledge and procedures which might assist in undertaking a detailed case study of a chosen topic. Students will be asked to structure their project around provided templates which will assist to develop two stages of STI policy-building: (a) identifying a particular STI Policy challenge, issue or problem, and (b) outlining a provisional strategy of sustainable planning or decision-making to address this. The project may be developed as a collaboration in pairs harnessing the power of cooperation and team-work as well as individual insight and applications. The chosen example should have at least some indirect connection to an aspect or focus of 'science, technology and innovation' and also the need for some kind of policy-building collaboration between organisations or interests from government, private/commercial, community and/or university sectors. For instance....

1. Exemplary higher education – industry – government – society collaborations involving both aspects of (a) science and technology and (b) sustainable policy-building implications.

2. **Authentic social and/or environmental issues, problems and challenges** which might be most effectively addressing with an integrated approach to linking 'science and technology' to knowledge management or organizational strategies of planning and decision-making

3. **Harnessing and applying existing science and technology** to address social and/or environmental challenges or problems. (and/or associated economic challenges/business opportunities)

4. **Exemplary instances of cutting edge/future 'science and technology'** (bio/nano-technology, renewable energies, digital technologies, etc.) with sustainable policy-building implications (green technology, sustainable development, innovation economy, and commercialization of research)

General Criteria: project development, teamwork (if done in pairs), case study analysis and application, innovation of policy solutions, demonstration of 'sustainable' policy-building

Figure 6. Summary overview version of MFT1053 project task

As indicated, sustainable policy studies linked to the emerging field of science, technology and innovation includes options which range from more specialised perspectives to interdisciplinary modes of complex problem-solving. Students were provided with models and templates to assist with this in terms of a how a sustainable problem-solving framework typically involves four distinct aspects and requirements or elements of integrated problem-solving and policy-building reflecting corresponding modes of human knowledge: 1. (communication, consensus and inter-dependence of) *stakeholder perspectives; 2. knowledge management*(of organizational vs. niche/individual/local human resources and performance) 3. *science and technology innovations* (applied knowledge building as extension); and 4. *complex environmental adaptation* (to changing natural vs. socio-economic contexts in time). These aspects provide the focus for outcomes-based problem-solving geared towards the 'optimization' of natural and human resources, an innovative as well as green approach to new science and technology solutions, and the process of achieving a foundation for sustainable 'change and improvement' in terms of a sufficient consensus of common purposes. As outlined such an approach requires a systemic alignment of the distinct if ultimately convergent axes of human knowledge-building. Students did not directly apply this framework in their projects but could use it to develop their selected problem focus in relation to the provided options.

3. 2 Activity-reflection e-portfolios as an overall 'culminating task'

As the culminating course task of problem-based learning, the MFT1053 project undertaken was also part of an overall e-portfolio assessment framework supported by a range of supporting individual reflections and activities. These had a formative as well as summative purpose in allowing progressive feedback to students about their achievement of course outcomes. The concept of an activity-reflection e-portfolio (Richards, 2005, 2013) builds on Kolb's notion that the most effective learning is that which constitutes an interplay of thinking and doing involving meaningful tasks to also harness the power of digital media to support such learning. As suggested earlier, the possibilities of achieving 'active learning' modes as an extended process across a particular syllabus or academic context are most fully realized in various kinds of project-based learning which involve the notion of a 'culminating task'. In various forms of problem-based and inquiry-based learning conducted as an authentic task or even as imaginary role-play and scenario, the notion of a culminating task of assessment synthesizes as well as supports an 'ecology' of targeted or projected outcomes linked to a central outcome or culminating task. Whilst the presentation of some kind of portfolio of reflections as well as applied learning tasks can be sufficient in itself to encourage this, the most effective curriculum framework for such optimized learning is to construct some particular project outcome.

Figure 7 below illustrates a sample activity-reflection e-portfolio from the MFT1053 course. In this particular course the e-portfolio involved a simple Word document saved as a html file with a hyperlinked file. Nonetheless it still provide a comprehensive and accessible learning profile in terms of formative as well as summative purposes tracking and archiving the related reflections and activities supporting the main project. Students are typically encouraged to develop such a profile into a professional e-portfolio beyond the purposes of the course. For assessment purposes, the e-portfolio further comprehensively maps and archives evidence of the outcomes achieved in the course. It supports the associated assessment marksheet used which as well as likewise providing a portfolio of critical feedback in relation to key items also lends itself to a formula for reconciling rubrics and criterion-based assessment and likewise converting qualitative indicators into an overall quantitative ranking.

MFT1053 Sustainable STI Policy Development
Learning Portfolio - *Name*

Personal/Professional profile

E……. is a student in UTM university in Malaysia. She is undertaking a Masters degree in Science, Technology, and Innovation Policy. Her prior academic study was a Bachelor degree in Chemistry. She has had about eight years of experience in international business management.

Professional philosophy for sustainable policy-building and integrated problem-solving [developing sustainable solutions for STI-related policy problems or challenges]

The concept of sustainable development is directed to provide a long-term vision for the society. For a community to function and be sustainable, the basic needs of its residents must be met. A socially sustainable community must have the ability to maintain and build on its own resources. It should also have the resiliency to prevent and/or address problems in the future. There are two types or levels of resources in the community that are available to build social sustainability (and, indeed, economic and environmental sustainability) - individual or human capacity, and social or community capacity. By improving innovative and sustainable problem solving, we can help organizations to better identify and focus on those problems they need to solve.

MFT1053 Collaborative project [with S……]

Abstract:
Social observers believe that obesity is an increasingly significant problem which needs to be be better dealt with in terms of public awareness. It is also a growing problem in Malaysia as well as many other countries. A particular aspect of this problem which our project focuses on is the challenge of getting government to require that the labeling of packaged foods include more accurate information about ingredients and nutritional value. In other words the policy challenge we want to investigate is how more accurate labeling might assist with the promotion of public awareness about the importance of health and nutrition in general, and the challenge of obesity in particular.

MFT1053 Project Artifacts

1. Bookmark file including relevant folders and links of STI resources and case studies
2. Project policy-building pyramid (and/or other planning items)

MFT1053 Reflections

Week 2: Introduction to the sustainability dilemma: Discuss the related social and technological issues represented by the Lynas Rare Earth Issue – and possible options for future directions with this.
Week 5: Requirements of a more sustainable public-private sector collaboration [re: smartphone or water industry examples discussed in class]

Figure 7. Sample activity-reflection e-portfolio profile from the UTM MFT1053 class

Students were expected to submit regular reflections in response to provided focus questions through out the semester. They did this by email in this course but could have uploaded to an e-learning content management program. In this format they receive feedback and have the option to respond to this in the final version of the e-portfolio. In this course the series of reflections supported both the development of their main project and supporting activities. For instance, the Week 5 reflection asked students to respond to the following:

> Wk 5: 1. As various examples from the newspapers show, STI policy-building often takes places in relation to industry – government – society collaborations which may also involve universities (especially for R & D and education/training). A focus of this week's class is to look at the challenge of achieving sustainable collaborations. Briefly discuss how a more sustainable public-private sector collaboration might be needed or achieved in relation to either the smartphone or water industry examples discussed in class

4.3 The enneagrammatic structure of 'integrated, optimal and sustainable' complex problem-solving

Students undertaking the MFT1053 course received weekly opportunities to consider possible solutions to authentic case studies in the challenges of achieving sustainable STI-related policy solutions. They were encouraged to adopt an outcome-based problem-solving approach which thus lent itself very appropriately to the outcomes-based learning and assessment approach adopted within the educational framing of the course. As outlined in the first section of this paper this involved approaches which not only would seek to break down complex problems in terms of their key contributing factors but also consider possible outcomes solutions and the issues of integration and implementation which would be needed to support these. One such model applied which also integrated some of the key aspects of sustainable knowledge-building promoted in the course is outlined in Figure 8 below. The enneagram model of 'integrated, optimal. and sustainable' complex problem-solving promotes the notions of transformative as well as sequential or cumulative stages of inquiry. But it also provides an exemplary framework for designing an outcomes approach to problem-solving in terms of a systems perspective and model.

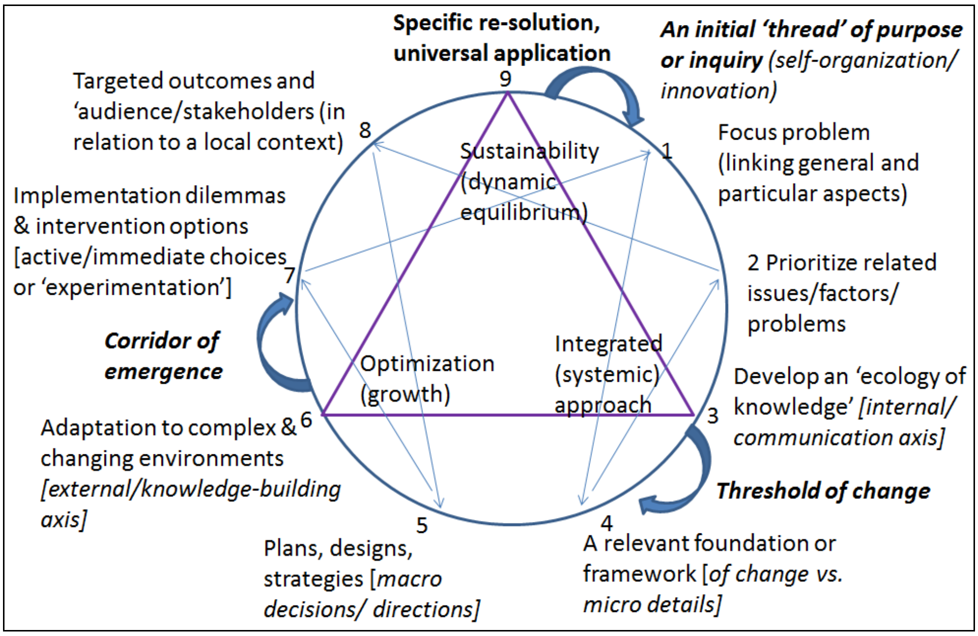

Figure 9.The enneagrammatic formula of integrated, optimal, and sustainable problem-solving. Adapted from Richards, 2013

The enneagram model used below represents a particular knowledge-building tool or method deriving from the Pythagorean tetractys which is also used for purposes of organisational learning, strategic leadership and decision-making (e.g. Knowles, 2003). As we have also discussed further elsewhere (Richards, 2013), it also exemplifies the structure of natural or human systems of knowledge. The intrinsic properties of the enneagram represent an interesting linking of geometic progression and a 'transformational' view of numbers in terms of the Pythagorean conception of the base 10 system. The triangular relation of the 3-6-9 numbers representing integration, optmisation and sustainability frame the 1-4-2-5-7-8 sequence which also is the intrinsic decimal pattern of any seventh fraction. Our representation here links to a number of related terms sustainable policy and knowledge building – notions of a 'threshold of change', a 'corridor of emergence', and the challenge of achieving 'dynamic equilibrium' .

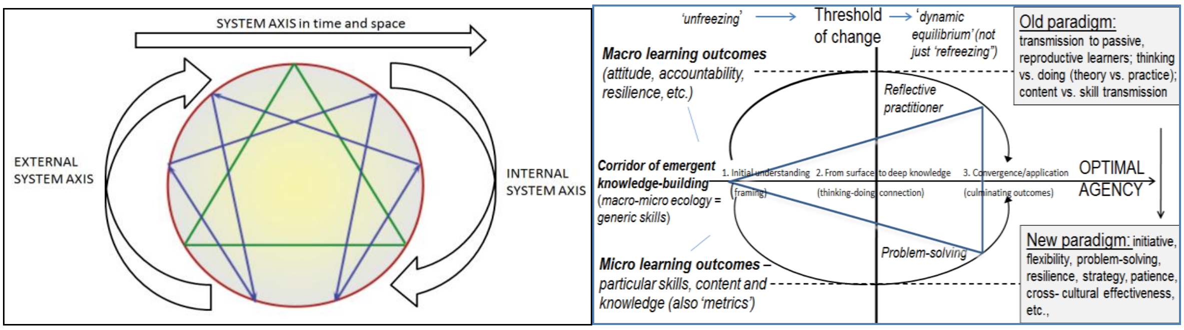

Figure 8.The enneagram and the convergent axes of 'unity' which inform human knowledge-building. Adapted from Richards, 2013

However our interpretation is that this is also usefully represents two linked systemic stages of outcomes-based knowledge transformation. As Figure 8 indicates, the enneagram functions as an exemplary model of how self-organising systems (especially those involving complex adaptation to changing contexts) typically involve internal or external axes of alignment which in human groups should involve both organisational functions of accountability or self-organisation and negative-vs. positive feedback loops. The related right-hand diagram indicates how it usefully exemplifies the corresponding processes of learning and inquiry. A new paradigm of integrated, optimal and sustainable problem-solving in learning thus involves the emergent knowledge reflected in the interplay of both macro and micro learning processes and outcomes. It thus also exemplifies the potential of the most effective problem-based learning designs and structures (Cf. also Pledge, 1983).

Conclusion

This paper has focused on how the natural human imperative for problem-solving in terms of adaptation to social as well as natural environments provides the key to the most effective learning, inquiry and also knowledge-building research (Powell & Ryzhov, 2012). It has discussed how the increasingly influential concept of problem-based learning has evolved in recent decades from its particular use in medical education for studying authentic cases to an interdisciplinary central pillar of the active or constructivist learning paradigm in schools and universities. The influence that a convergent PBL model has had on encouraging enhanced collaborative inquiry and problem-solving in professional as well as academic and even technical or competency-based education is also one that can and should be replicated in terms of more interdisciplinary, collaborative and outcomes-based (and not just evidence-based) inquiry within and beyond university contexts of partnership. After all the University students should ideally also learn in terms of active modes of thinking and knowledge-building applicable to both authentic real-life contexts and the additional university purpose of encouraging and supporting effective research in various senses of the term.

A general model of PBL in schools has typically encouraged cross-disciplinary collaboration and knowledge sharing (i.e. it is common for members of school problem-based learning projects to take on different roles, purposes and modes of knowledge-building). This has not typically been the case in higher or continuing professional education contexts where the emphasis is often on specific cases in terms of specialised knowledge. The paper has developed an argument that a convergent model of PBL exemplifies as well as encourages the kind of approach needed to to address the increasingly complex and diverse 'wicked' problems facing the world in every aspect of both the social and natural domains of human life and activity. Thus the final section of the paper has outlined the cross-disciplinary inquiry implications of how a generic model of complex problem-solving which systematically proceeds in terms of a basic three-stage method of: (a) breaking down overriding or central problems into their main contributing domains and factors; (b) also focusing on these domains and factors separately as well as together in terms of seeking feasible solutions, and (c) building towards an overall strategy and proposed solution in terms of an integrated and systemic approach which reflects 'the whole as well as the sum of its parts'. The further discussion of an 'enneagrammatic formula of integrated, optimal, and sustainable problem-solving' has served to exemplify the possibilities of an integrated systems approach to problem-based learning as well as the generic problem-solving process in every aspect of both social and natural domains of human knowledge.

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References

Armstrong, S. (2012). Natural learning in higher education, *Encyclopedia of the Sciences of Learning*, Springer.

Barrows, H. & Tamblyn, R. (1980). Problem-based learning: An approach to medical education. New York: Springer.

Barrett, R. (2006). *Building a Values-Driven Organization: A Whole System Approach to Cultural Transformation*, ISBN 9780750679749.
Bertalanffy, L. (1974). *Perspectives on General System Theory*, George Braziller.
Biggs, J & Tang C. (2011). *Teaching for quality learning at university*, McGraw-Hill.
Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18(1), pp32–42.
Christensen, H. (1997) *Disruptive Innovation*, Harvard Business Review Press.
Forrester, J. (1991). System dynamics and the lessons of 35 years. in The systemic basis for policy making in the 1990s, ed. K. De Greene,
Fricke, M. (2009). The knowledge pyramid: A critique of the DIKW hierarchy, *Journal of Information Science*, 35, 2, 131-142.
Gallwey, T. (2009). *The Inner Game of Stress: Outsmart Life's Challenges, Fulfil Your Potential, Enjoy Yourself*. New York: Random House.
Jonassen, D. et al (2003). *Learning to solve problems with technology*, Prentice Hall.
Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16, 235-26
Klein, J. (2004). Interdisciplinarity and complexity: An evolving relationship, *E:CO*, 6, 1, 2-10.
Kolko, J. (2012). *Wicked problems: Problems worth solving*, Austin Center for Design.
Kolb, D. (1984). *Experiential Learning*, Englewood Cliffs, NJ.: Prentice Hall.
Knowles, R. (2003). *The leadership dance*, Center for Self Organizing Leadership
Meissner, D. Gokhberg, L. & Sokolov (2013). *Science, technology and innovation policy for the future*, Springer.
Laszlo, E. (1972). The systems view of the world. The natural philosophy of the new developments in the sciences. George Brazillier.
Mitleton-Kelly, E. (2003). *Complex systems and evolutionary perspectives on organisations*, Elsevier
Paul, R. & Elder, L. (2002). *Critical thinking: Tools for taking charge of your professional and personal life*, FT Press.
Pledge, K. (1983). Structure process in scientific experiments, in J.G. Bennett's *Enneagram Studies*, Samuel Weiser, Inc., 84-122.
Prigogine, I. & Stengers, I. (1984). *Order out of Chaos: Man's new dialogue with nature*. Flamingo
Richards, C. (2005). Activity-reflection e-portfolios: An approach to the problem of effectively integrating ICTs in teaching and learning, *Teaching and Learning Conference*, Murdoch University, Feb. 2005. http://lsn.curtin.edu.au/tlf/tlf2005/refereed/richards.html
Richards, C. (2012a), ICTs and assessment for student-centred learning strategies. *Educate 12: Assessment and Transformation in Higher Education*, Intercontinental Hotel, 3-4 July Refereed online proceedings. Available at http://www.monash.edu.my/academic-services/eq/images/stories/educate12/day1_plenary3_proceedings.pdf
Richards, C. (2012b). Sustainable Policy Making and Implementation: Towards a new paradigm for a changing world, *Development Review*, Vol. 21, Bangladesh National Academy.
Richards, C. (2013). Old wisdom for a new world in crisis? *E:CO* , 15, 1 , pp. 11-32
Ricoeur, P. (1994). *Interpretation theory*, University of Chicago Press.
Seely Brown, J & Duguid, P. (2002) *The social life of information*, Harvard Business School.
Spady, W (1993). *Outcomes-based education.* Workshop Report Number 5. ACSA, Canberra.
Trilling, B. & Fadel, C. (2009). *21st century skills: Learning for life in our times.*Jossey-Bass.
Wenger, E. (1999). *Community of practice: Learning, meaning, and identity*, Cambridge Uni. Press.

Motivation and Learning Strategies: Promising Outcomes of Cooperative Problem-based Learning

Syed Ahmad Helmi [a 1], Khairiyah Mohd-Yusof [b], Fatin Aliah Phang[c] , Shahrin Mohammad[d], Mohd Salleh Abu[c]

[a]Centre of Engineering Education & Faculty of Mechanical Engineerinng, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[b] Centre of Engineering Education & Faculty of Chemical Engineerinng, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[c] Centre of Engineering Education & Faculty of Education, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia
[d] Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor, Malaysia

Abstract

Solving complex engineering problems is an essential skill that must be developed among graduates of the new millennia. Issues facing the world today are very challenging, and will become more challenging in the future. Thus, to become good problem solvers, graduate engineers of today must be motivated and equipped with learning strategies that will allow them to adapt o future requirements as self-directed learners. Evidence show that engineering students who had gone through Cooperative Problem-Based Learning (CPBL) become highly motivated and are strategic learners. CPBL is the infusion of Cooperative Learning (CL) principles in to the Problem-Based Learning (PBL) cycle that is used for effective implementation in a typical class. The question is how do the students acquire these attributes that influence the development of their problem solving skills? Based on qualitative analysis, four elements, expectancy, extrinsic motivation, intrinsic motivation and task value were grouped under motivation, and another four elements, organization, critical thinking, effort regulation and help seeking were grouped under learning strategies. Based on the findings, a model of motivation and learning strategies as a sub-model for enhancing engineering students' team based problem solving skills through (CPBL) is proposed.

Keywords : Motivation and Learning Strategies, Problem Solving, Cooperative Learning and Problem-Based Learning.

1. Introduction

Students' motivation and learning strategies play very important role in driving learning (Svinicki, 2005). It is one of the main bases for engagement - whether a person decides to spend his time and effort on a certain task (Urban and Schoenfelder, 2006). Cooperative Problem-Based Learning (CPBL), which is the infusion of Cooperative Learning principles into the Problem-Based Learning (PBL) cycle to allow effective implementation with small groups in a typical medium size class, had been shown to shape attitudes, motivate students to learn and develop effective learning strategies (Helmi, et al., 2012; Mohd-Yusof, et al., 2011). CL is a systematic team working approach in learning where all five CL principles, such as positive interdependence, face-to-face interaction, individual accountability, development of interpersonal skills and regular team function assessment, are applied (Johnson, Johnson and Smith, 2002, and Smith and Imbrie, 2004). PBL is a student-centred, inductive-based learning methodology, where using self-directed learning to solve ill-structure problems are the core principles (Prince and Felder, 2006; Hmelo-Silver, 2004; and Barrows and Tamblyn, 1980). Because of the challenges of CL and PBL in solving complex problems, if not properly facilitated, students can be de-motivated and give-up (Mohd-Yusof and Helmi. 2009). Nevertheless, with good facilitations and properly implementing CL and PBL, students' motivation and learning strategies will tremendously increase.

The learning environment within Cooperative Problem-Based Learning (CPBL) is in accordance with the expectancy-value theory. Expectancy-value theory states that students choose to engage in a task that they expect to succeed in, and that they deem to be beneficial if they completed the task successfully. As mentioned by Eccles and Wigfield (2009), and reported by Matusovich, Streveler and Miller (2009), expectancy-value theory conceives that motivation to perform a learning task depends on two dimensions: "expectancy of success" in the given task, and the "value" attributed to effectively performing the task. Expectancy of success is related to three factors: (a) how a learner attributes his past success or failure; (b) how a learner perceives competence; and (c) how a learner maintains self-esteem. The "expectancy" dimension answer to the question of "Can I do this task?" The second category of expectancy, the value theories answers to the question of "Do I want to do the task?". Based on the motivational theories, Liao (2005) suggested that in order to enhance motivation, instruction needs to help learners perceive competence as acquired skills and to enhance their sense of control over learning tasks. Making the learners believe that excellence is achievable by efforts and that they can make a difference, is attainable by enabling students to make improvements on their past self-performance rather than being graded by the performance of others. In CL, this pedagogical practice is called "equal opportunities for success" (Liao, 2005).

Supporting and monitoring students' learning in small groups by a floating facilitator can be challenging in a typical class while implementing PBL. It is typical for students to become de-motivated by working in groups, be it in laboratories or class projects, because of negative prior experiences (Felder and Brent, 2007). Therefore, in PBL, the support needed does not only involve cognitive coaching, but also, guidance and monitoring to develop team working skills in students. In a proper CL environment, part of the monitoring, support and feedback can be attained from peers, especially team members, instead of solely relying on the facilitator. In fact, support can be further enhanced by developing the whole class into a learning community. To achieve this, Duch, Groh, and Allen (2001) and Prince (2004) suggested CL aspects to be integrated with PBL. Thus, it is only logical to have a model that integrates both CL and PBL to become Cooperative Problem Based Learning (CPBL) to take advantage of the natural synergy between them. With proper facilitation and scaffolding, students going through CPBL courses were more positive towards learning compared to those undergoing traditional lectures, and hence it is not surprising to see them develop challenging skills such as solving complex problems (Helmi, et al., 2012; Jamaluddin, et al, 2012).

2. Research Methodology

The research question is how do the students improve their learning motivation and their employment of learning strategies that will eventually enhance their problem solving skills? The question is answered using qualitative analysis. The research methodology used constant comparative method to study the process, or look for explanation of the process.

The question is investigated from series of students' reflections and interviews from 2 groups of students. In this qualitative methodology, the research questions focused on the CPBL approach, on students describing their experiences mainly through interviews and reflection journals. The CPBL approach consists of the CPBL cycles and problems organization. Students reflected upon their works at the end of every problem they solved. Researcher interviewed several students at the end of the semester. The students' reflections and the interviews are analyzed using NVivo 8 and themes emerged from the reflections and interviews are analyzed. Emerging themes are considered as saturated if they were frequently mentioned (Corbin and Strauss, 2008). As a rule-of-thumb, themes emerged more than seven times is considered as saturated. The themes are considered triangulated if they emerged from many different sources (Creswell, 2007). In this study, the researcher's role is like an "instrument" through which the reality of the students' problem solving skills enhancement is explored. The researcher's presence is acknowledged, both by the students and the lecturer.

2.1 Technical Characteristics

The reliabilities of the emerged themes in the reflection journals and interviews are conducted using Cohen's Kappa (Fleiss, Levin and Paik, 2003). According to Landis and Kosh (1977), if index of Cohen's Kappa (K) is greater than 0.81, the reliability of the themes are considered as very high. Samples of coding and its' respected themes are given to three (3) experts for the reliability analysis. The three experts are the CPBL expert, the problem solving expert, and the qualitative analysis expert. The results of the analyses show that the themes are totally reliable, with K = 1.0 from all the experts. Thus, all the emerged themes can be applied in the analysis.

3. Data Gathering and Analysis

A summary of themes emerged from the investigation and numbers of the themes repeated are shown in Table 1. From the analysis, motivation and learning strategies is divided into two elements: motivation strategies and learning strategies.

In the motivation element, themes such as expectation, intrinsic goal orientation, extrinsic goal orientation, and task value emerged. In the learning strategies, themes such as critical thinking, effort regulation, help seeking, and organization emerged. All the themes were mentioned several times, with help seeking theme emerging the most, followed by effort regulation. The next theme that was mentioned most is their intrinsic goal orientation. Table 2 shows samples of data related to the themes. This table, together with Table 3 shows how students improve their learning motivation and their employment of learning strategies that will eventually enhancing their problem solving skills.

Table 1: Open coding and repetition of themes for motivation and learning strategies

Motivation and Learning Strategies	Reflections				Interviews		∑
	Problem 1	Problem 2	Problem 3	Meta	Group 1	Group 2	
Motivation:							
Expectancy	5	3	3	3	1	4	19
Intrinsic	4	2	6	2	2	4	20
Extrinsic	2	3	5	1	2	4	17
Task Value	1	2	4	0	0	2	9
Learning Strategies:							
Organization	3	2	2	1	3	2	13
Critical Thinking	4	1	4	1	2	2	14
Effort Regulation	5	5	2	3	3	4	22
Help Seeking	7	4	6	2	2	4	25

Table 2: Samples of open coding for motivation and learning strategies

Elements	Sample Data	Open Coding
Motivation Strategies:	I won't be able to learn a new thing if I easily give up trying and learning from mistakes. We learn from mistakes. If I keep on trying and am persevere, then eventually I will be able to master the things I am learning.	Intrinsic
	As for Simulink, it was totally new to me. It was fun and interesting, seeing how graphs can be produced and learning how to analyze the graphs.	Task Value
Learning Strategies	With more feedbacks and comments, the original solution is improved and made better, and eventually the problem can be solved in a better way.	Critical Thinking
	Looking at the syllabus, I noticed that I can see the connection of all the 3 phases. Problem statement must be clear before confronting the problem.	Organization

4. Research Findings

How the students enhanced their motivation and learning strategies upon going through CPBL is shown here. In this study, the two most frequent themes in motivation are intrinsic goal orientation and expectancy, respectively. This is then followed by extrinsic goal orientation. Upon undergoing CPBL for one semester, the students' motivation in learning is driven by their intrinsic goal orientation. As stated by student A,

> "I won't be able to learn a new thing if I easily give up trying and learning from mistakes. We learn from mistakes. If I keep on trying and am persevering, then eventually I will be able to master the things I am learning."

This statement illustrated the intrinsic value component of the student's goal orientation, as he emphasizes his effort of not giving up due to his quest for knowledge. The next most frequent theme in motivation is expectancy. The expectancy component measures students' expectation for success in a course. This is mentioned by student A, as he said,

> "I realized that if all of us contribute our parts during discussions, the outcome will be better as there are more ideas being generated."

Student A highlighted that in order for him to succeed in the course, he need to contribute more in group discussion. As for the extrinsic goal orientation, a student stated that,

> "As overall, I am very happy to have a great time during this class although sometimes I have a hard time. Lastly, for sure I need to get A in this subject."

He concluded his statement of happiness and working hard with his expectation to get the best grade for the course. This extrinsic goal orientation will motivate him to work hard and finally achieved the reward of his expectation. In this study, intrinsic goal orientation is mentioned more than extrinsic goal orientation. This signals that students are more into the problems with curiosity, as a challenge to master their understanding compared to their grades and rewards. Though, both are considered important for them. Another important theme that emerged in the reflections and interviews is task value, for example, student B stated,

> "As for Simulink, it was totally new to me. It was fun and interesting, seeing how graphs can be produced and learning how to analyze the graphs."

This statement shows the degrees to which the students perceive the course material in terms of interest, significance, and usefulness. All these statements show the students' learning motivation, which are very important pre requisites to overcome and sustain the challenges in solving complex and open-ended problems such as the problems in CPBL.

The enhancements of students' learning strategies can be understood from important themes that emerged in students' reflections and interviews. Among all the themes, help seeking is most frequently mentioned. In fact, it is the most mentioned in this spotlight. Help seeking is about enlisting the support of others. As student C reflected,

> "When we are discussing about certain topics, we help each other to understand the topic better."

This shows how the students properly utilize resources and actively pursue assistance to enhance their learning strategies. The next most mentioned theme is effort regulation, as revealed by student D,

> "First we need to study like mad people and then vomit it out to our team mate then only the real thing will come, a clearer picture of the content. It actually happens on all the four phases where we don't know anything but at last produces something."

This shows how the student was persistent in pursuing his learning goals even in the face of difficulties or boredom. Both of these themes, help seeking and effort regulation, indicate how the students enhance their resource management strategies as an important element in learning strategies. Other important themes that also emerged in this analysis are critical thinking and organization. An example of critical thinking which emerged through overall group discussion, student E said,

> "With more feedbacks and comments, the original solution is improved and made better, and eventually the problem can be solved in a better way."

The statement shows how the student's problem solving skills is enhanced through the CPBL process. Organization refers to making connections between substances to be learned. With this regards, student F mentioned,

> "Looking at the syllabus, I noticed that I can see the connection of all the 3 phases. Problem statement must be clear before confronting the problem."

The emerging themes of critical thinking and organization indicate the use of cognitive and meta-cognitive component in problem solving. It shows how the students improved their thinking approach through connecting and representing knowledge to better understand, and making justified judgments as well as to transfer and apply knowledge in a different context.

Figure 1 shows the open, axial and selective coding of the analysis. The elements of motivation and learning strategies are considered as the axial coding that group all the themes into two categories. The selective coding is designated as motivation and learning strategies, which is the integration of the motivation strategies and the learning strategies, since both are closely inter-related to one another.

5. Discussion

The constant comparative method had been used in the analysis to find answer to the research question of how do the students improve their learning motivation and their employment of learning strategies that will eventually enhance their problem solving skills. From the analysis of the qualitative data, this paper presents the development of a sub-model of the enhancement, illustrated in Figure 2. The model symbolizes two intertwined characteristics of students who had undergone CPBL: enhanced motivation and learning strategies. There are four elements that influence how students develop their overall motivation: expectancy, intrinsic, extrinsic and task value. There are also four elements how students enhance their learning strategies: organization, critical thinking, effort regulation and help seeking.

Elements that enhanced students' motivation is in accordance with the expectancy value theory, which is also supported by the quantitative findings on the same cohort of students who had undergone CPBL in the same cohort (Mohd-Yusof, et. al., 2011). Students were found to enhance their intrinsic and extrinsic motivation towards learning as they go through CPBL, which is consistent with studies on PBL that found to develop positive attitude in students (...). This is not surprising, because students believe the tasks that they were doing in CPBL is of value, and will help develop them into good engineers in the future. This finding is, again, consistent with the aim of using real, or at least, realistic problems in PBL, that serves to contextualize the knowledge that is being learned. Another strong element that emerged, expectancy, shows that students believe that they can succeed if they put in effort, even though the task may initially seem to be difficult. This caused them to go on and not give up.

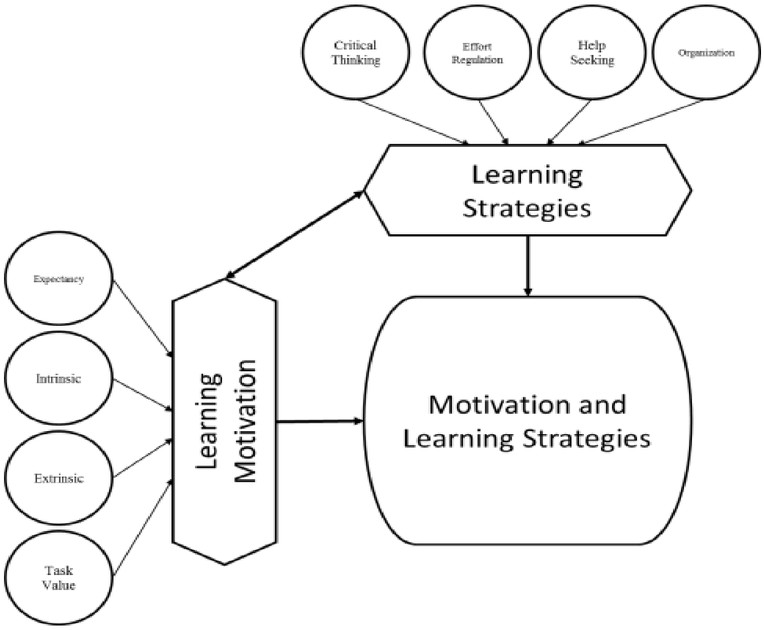


Figure 1: Open, axial and selective coding for sub-model enhancement of engineering problem solving skills (motivation and learning strategies)

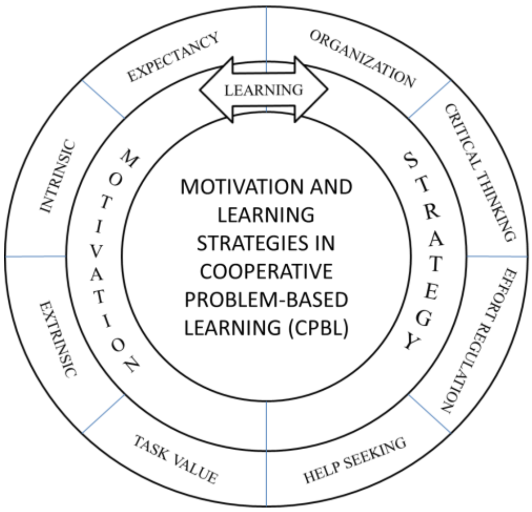


Figure 2: Motivation and learning strategies: sub-model of enhancement engineering problem solving skills through CPBL

The findings on the elements in value and expectancy are also consistent with the social interdependence theory which underpins CL. Social interaction among learners can create collaboration, leading to a significant positive impact on learning (Jonnasen, et. al., 1995; Johnson, et. al, 2006). This effect can be seen among students, when they realize that by having each of them putting in effort, the team will be able to produce better quality output than any of them can produce on their own.

The data that shows enhancement of the elements in learning strategies are closely intertwined with the motivation elements. Elements, such as help seeking and effort regulation, show a lot of times how working together in CPBL in a cooperative manner motivated and enabled them to reach a higher level in learning and solving the problem. Having their team mates and the whole class as a learning community made the students realize that they can rely on one another to learn, and that they are not alone in facing the difficult tasks and problem. As they go through CPBL, students develop the ability to better manage and utilize the resources that is available to them in learning

Cognitive and meta-cognitive elements can be seen in the way students became critical thinkers and organize their learning. As they go through the CPBL cycles, working through one problem after another until they reach the fourth problem at the end of the semester, they begin to realize that they cannot accept just one source of information, and they realize that although there are many possible solution, they need to come up with the best solution for the given condition and justify why they think it is the best. They manage to identify how to best organize information and make connections, as well as identify how they should improve their learning and problem solving process. This is consistent with the constructivist underpinning of PBL, which not only forces students to learn new knowledge required to solve the problem, but also to reflect upon their learning through the PBL process, thus making them self-directed learners.

6. Conclusion

This qualitative study shows that CPBL is able to enhance the desired cognitive and affective skills as in PBL and CL. Students were shown to enhance their strategies in learning, as well as become motivated in learning. By integrating CL and PBL, students were able to gain the best of both approaches, while overcoming the typical shortcoming of not having a dedicated facilitator. Therefore, the CPBL model can be used in a typical class without compromising the desired outcomes.

References

Barrows, H. S. and Tamblyn R. M. (1980). *Problem-based Learning: An Approach to Medical Education*, New York, Springer.

Biggs, J. and Tang, C. (2011), *Teaching for Quality Learning at University*, 4th Ed., The Society for Research in Higher Education, McGraw-Hill International, New York, USA

Corbin, J. and Strauss, A. (2008). *Basics of Qualitative Research* (3rd Ed.). Los Angeles, CA: Sage

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing among Five Approaches* (2nd edition). Thousand Oaks, CA: Sage.

Duch, B.J, Groh, S. E., and Allen, D. E. (2001). *The Power of Problem-based Learning*. Virginia, USA: Stylus Publishing.

Eccles, J and Wigfield A. (2002). Motivational Beliefs, Values and Goals, *Annual Review of Psychology,* 53:109-132

Felder, R. M. and Brent, R. (2007). "Cooperative Learning", in Active Learning: Models From the Analytical Sciences, P. A. Mabrouk Ed, ACS Symposium Series 970, Chapter 4. *American Chemical Society*. Washington DC, pp. 34-53.

Fleiss, J. L., Levin, B., and Paik, M.C. (2003). *Statistical Methods for Rates and Proportions*. 3rd edition. New York: John Wiley & Son, Inc.

Helmi, S. A., Mohd Yusof, Mohammad, S and Abu, M. S. (2012), Methods to study ehnacement of problem solving skills in engineering students through cooperative problem-based learning, *Procedia – Social and Behavioral Sciences.* Vol. 56 (2012), pp. 737-746

Jamaluddin, M. Z., Mohd-Yusof, K., Harun, N. F., and Helmi, S. A. (2010). Crafting Engineering Problem for PBL Curriculum, *Procedia – Social and Behavioral Sciences,* Vol. 56 (2012), pp. 377-387

Johnson, D. W., Johnson, R. T., and Smith, K. A. (2006). *Active Learning: Cooperation in the College Classroom*, Interact Book Company, Edina, Minnesota

Landis, J. and Kosh, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33: 159-174.

Liao, H. –C. (2005). *Effects of Cooperative Learning on Motivation, Learning Strategy Utilization, and Grammar Achievement on English language Learners in Taiwan*, PhD Thesis, University of New Orleans, USA.

Matusovich, H., Streveler, R., and Miller, R. (2009). "What does Motivation Really Mean? An example from current engineering education research", *Proceedings of the 2009 Research in Engineering Education Symposium*, Palm Cove, Queensland, Australia.

Mohd-Yusof, K and Helmi, S. A. (2009). Effect of Facilitation on Outcomes and Students' Perception in Problem-based Learning, *Proceeding for 2nd International PBL Symposium*, Singapore.

Prince, M. J. and Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education 95* (2): 123–38.

Prince, M.J. (2004). Does Active Learning Work? A Review of the Research, *Journal of Engineering Education*, 93(3), pp. 223-232.

Smith, K. A. and Imbrie, P.K., (2004). *Teamwork and Project Management* (2nd Ed.). Boston, MA: McGraw-Hill.

Svinicki, M. (2005). Student goal orientation, motivation and learning, *IDEA Paper 41*, , accessed Feb 28, 2013.

Urdan, T. and Schoenfelder, E. (2006). Classroom effects on student motivation: Goal structures, social relationships and competence beliefs, *Journal of School Psychology* 44

A Longitudinal Study on the Impact of Cooperative Problem-Based Learning in Inculcating Sustainable Development

Azmahani Abdul-Aziz[a]*, Khairiyah Mohd-Yusof[a], Amirmudin Udin [b], Jamaludin Mohamad-Yatim [c]

[a]Centre of Engineering Eduction, Universiti Teknologi Malaysia, Johor Bahru and 81310, Malaysia
[b]Faculty of Education, Universiti Teknologi Malaysia, Johor Bahru and 81310, Malaysia
[c]Faculty of Civil Engineering, Universiti Teknologi Malaysia, Johor Bahru and 81310, Malaysia

Abstract

The purpose of this study was to investigate the impact of Cooperative Problem-Based Learning (CPBL) in inculcating sustainable development amongst first year engineering students. A longitudinal quantitative research methodology was carried out over three semesters to determine the changes. Students were experienced with a real problem related to sustainable issues. Precaution Adoption of Process Model (PAPM) was used as a tool to assess the students' behaviour change which focuses on pro-self and pro-social development towards practicing sustainable lifestyles. Result showed that the implementation of CPBL as a teaching and learning approach has a positive impact on students' development. The findings also found that elements of sustainable development should be embedded into the curriculum on the following semester to gain a continuous impact on students.

Keywords: Teaching and learning approach

1. Introduction

The challenge of 21st century engineering students is to look for the best solution to an engineering problem with sustainable development constraint in mind. However, previous research on first year engineering students in Malaysia [1,2,3] has shown a lack of knowledge about sustainable development and practicing as a lifestyles. Currently, several initiatives have been done by the government and non government organization to promote sustainable development. While at higher educational level, topic on sustainable development becomes an important issue that should be embedded into their academic or non-academic programmes. Therefore, today's engineering educators are facing higher responsibility to educate future engineers with engineering 'habits of mind', which include system thinking, creativity, optimism, collaborative, communication, and attention to ethical considerations [4].

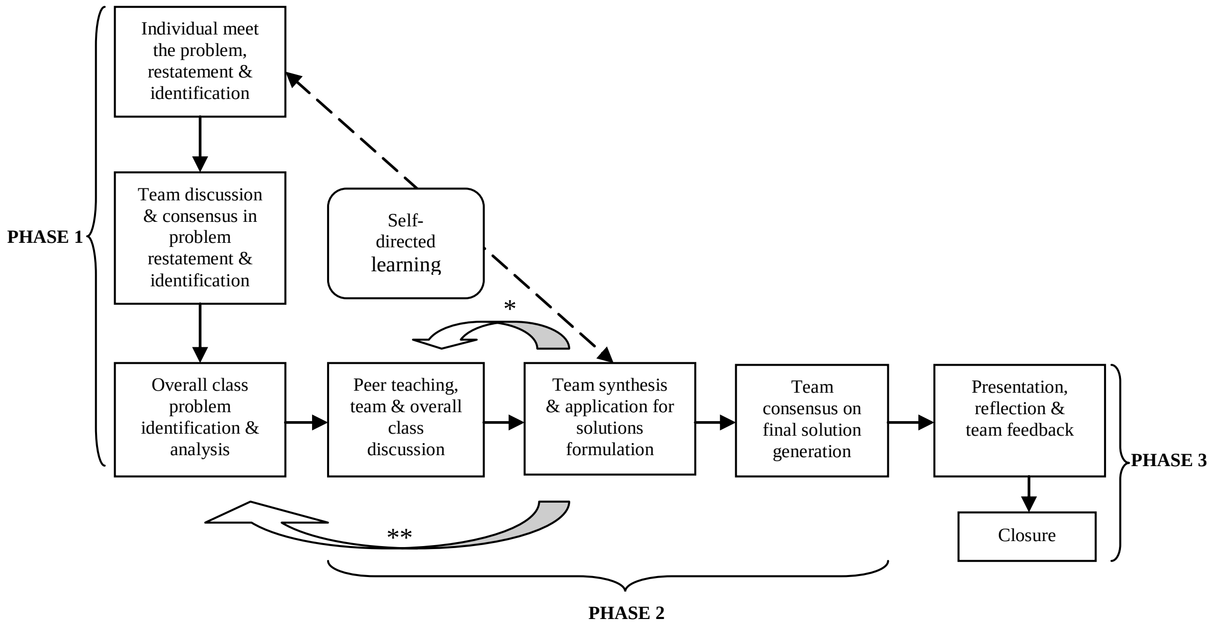
In line with the needs, educators should make a paradigm shift through pedagogical approach from passive learning to active learning. Active learning has been shown to enhance learning [5]. Active learning techniques, especially the Cooperative Learning (CL) and Problem Based Learning (PBL) are currently being promoted across all disciplines as well as levels of studies [6,7,8]. Both are instructional methods where students "learn to learn," working cooperatively in groups to seek solutions to real world problems. PBL prepares students to think critically and analytically, and to find and use appropriate learning resources [9,10].

Thus, the purpose of this study was to investigate the impact of Cooperative Problem-Based Learning (CPBL) in inculcating sustainable development amongst first year engineering students. Sustainable development can be introduced through formal learning and non-formal learning. This study focused on formal learning where topic on sustainable development is a part of course content under 'Introduction to Engineering' course. Longitudinal quantitative research methodology was utilized to observe and assess students' behaviour change associated to sustainable development before and after undergoing the course.

2. Cooperative Problem-based Learning (CPBL)

Cooperative Problem-based Learning (CPBL) is a hybrid of two models of learning methods; Cooperative Learning (CL) and Problem-based Learning (PBL). It integrates cooperative learning principles into the PBL cycle. CL was known to promote five principles; positive interdependence, individual accountability, face to face interaction, appropriate interpersonal skills and regular team role assessment [11,12,13]. In a team, social interaction among students can create collaboration in the learning activities. The positive learning environment would yield strong interaction among learners in a cooperative and supportive environment. Member in a team has a responsibility to support and facilitate each other's effort to reach the goal. Several studies of cooperative learning have been conducted in Malaysian context have found that cooperative learning promoted positive relations among students and there was a tendency to be more cooperative among the peer members in discussing and solving problems such [14,15].

* Corresponding Author name. Tel.: +6-07-553-1605
E-mail address: azmahani@utm.my



*Insufficient understanding of learning issues to solve problem
**Incomplete or misunderstanding of problem requirements

Figure 1: Cooperative Problem-based Learning Framework
(Source : Mohd-Yusof K. et. al. 2012)

Problem-Based Learning (PBL) is an inductive learning approach that has been used successfully for over 30 years [7]. It embeds small groups of students and presents them with a messy, unstructured, realistic (if not real) problem, to solve. The problem should be well crafted to engage and immerse students in learning new issues. Instead, students are guided through a PBL cycle that helps them to identify and construct new knowledge that is synthesized with their existing knowledge to be applied in solving the given problem. Students are guided by cognitive coaches or floating facilitator through the PBL cycle to learn and solve the problem.

Hence, CPBL model is the integration of CL into the PBL cycle as shown in Figure 1. Two premises in constructive alignment are grounded to develop the CPBL model, which are 1) constructivism, where student constructs meaning through his/her learning activities and 2) instructional design that aligns learning outcomes of teaching and learning activities, as well as assessment task [11]. The CPBL learning environment is underpinned by four principles; constructive alignment, PBL as a philosophy, cooperative learning and how people learn (HPL) framework. HPL framework consists of four lenses i.e. knowledge centred, student centred, community centred and assessment centred. This framework was utilized to analyze and design learning environment. The CPBL framework is scaffolding that successfully provides a step by step guide on how to go through each phase of the process. Referring to Figure 1, the typical CPBC cycle consists of:

- Phase 1 : Problem restatement and identification
- Phase 2 : Peer teaching, synthesis of information, and solution formulation
- Phase 3 : generalization, closure and reflection

In each phase, the individual activities are designed to enhance learning and accountability, followed by team-based activities and finally in the overall class activities to form a learning community.

3. Research Questions

This study attempted to assess the students' behaviour toward practicing sustainable lifestyles after undergoing cooperative problem-based learning as a teaching and learning approach. This study addressed the research question; to what extend does CPBL could inculcate students' behaviour change associated to pro-self and pro-social development in practicing sustainable lifestyles.

4. Research Methodology

The study was carried out among a group of 120 first years chemical engineering students (45% male and 55 % female) took 'Introduction to Engineering' course. This course embedded knowledge about sustainable development through a problem.

CPBL was implemented as a teaching and learning approach to give guidance and facilitate the students to carry out the problem. The students were selected as a respondent of this study for three semesters. A questionnaire was administrated at three different periods, which were at the beginning of semester 1, end of semester 1 and beginning of semester 3(Year-2). They were given the same questionnaire to determine their levels of knowledge and behaviour change. The instrument consists of 25 items divided into five parts (demographic data, sustainable issues, content knowledge, pro-self and pro-social) has been tested for goodness fit of model through the analysis of structural equation model using AMOS. Table 1 shows the examples of items in the instrument.

Table 1. Example of Items in Instrument

Scales	Subscales	Code	Items
Knowledge	Environmental issues	KT1	Air Pollution
		KT2	Climate Change
	Concept of SD	KBK1	Definition of SD
		KBK2	Three components of SD
Pro-environmental behaviour	Self Development	BSf18	I turn lights off when I leave a room
		BSf19	I turn tap off when brushing my teeth
	Social Development	BSc17	I actively participate in SD programmes
		BSc20	I donate money to support SD programmes

4.1.Description of a Problem and Procedure

Students were divided into teams of five. Each team is required to fulfill all the stages, rules, regulations and finally competed with other teams for the grand prize in a solid waste management campaign day. The project was designed to integrate the three pillars of sustainable development along with the students completed all the stages as showed in Table 2.

Table 2. Stages of Project

Stages	Title	Duration
1	Waste Characterization and Benchmarking	2 weeks
2	Life Cycle Assessment (LCA)	4 weeks
3	Propose Engineering Solution Based on 3R Concept	4 weeks
4	Campaign Day	1 day

Each team is required to propose engineering solution to reduce, reuse and recycle (3Rs) of waste and to choose the area of study where they currently live (e.g. their campus area). Throughout the period, they are given the privilege to acquire expert consultation from an experienced researcher working in the field via online forum. In addition, they are also encouraged to consult other experts such as academicians, environmental consultants, etc. At the end of each stage, they should submit their staggered progress report and mini presentation will be held for the selected team. Advisers will be appointed to guide the participating teams throughout the competition.

Finally, they are required to submit a comprehensive final written proposal that followed the proposal specifications guidelines. In addition, they are encouraged to consider several sources such as latest technologies as well as applied research, designed to provide benefits to people who generate waste and to public and private entities responsible for reducing, reusing and recycling of waste. The proposal should call for an increase in the ratio of recyclable materials, further reusing of raw materials and manufacturing waste, and overall reduction resources and energy used. Nonetheless, all materials used in the proposal should be clearly and properly cited. The winning proposals are viewed to be most environmentally-sound as well as economical viable based on 3R concept. Through the CPBL learning environment, students will develop and understand the principles of sustainable development and how it applies over the whole life of a product from raw material through design, manufacture, use and final disposal.

4.2 Teaching and Learning Activities

During completing the problem, students were exposed to CPBL model as their teaching and learning approach. Figure 1, Table 2 and Table 3 show the connection among CPBL phases, sustainable problem and learning activities. The activities for each stage were designed to be aligned with CPBL phases. Since this learning environment is very new to the students, a dedicated tutor or floating facilitator will be around to facilitate during class time. A series of discussion will be held outside the classroom in order to produce a final report and presentation. In all activities (individual, team and class), CL principles were integrated into PBL cycle to form a successful team. Therefore, students must be in functional teams so that they can harmoniously cooperate and support one another.

Table 3. Summary of CPBL Phases and Learning Activities

Stages	CPBL Cycle	Learning Activities
1,2 & 3	Phase 1 : Problem restatement (PR) and identification (PI)	Individual PR and PI Team PR and PI Class Discussion
	Phase 2 : Peer teaching (PT), synthesis of information, and solution formulation	Individual PT notes Team PT notes Class PT (selected team)
	Phase 3 : generalization, reflection and closure	Individual Reflection Peer and self –rating, Final report

4.3. Assessment Tool of Behaviour Change

Weinstein and Sandman (1991) proposed the Precaution Adoption Process Model (PAPM) of changing individual behaviour which consists of seven stages. These stages were used as level of agreement in instrument to assess students' behavioural in practicing sustainability. The model asserts that people usually pass through this sequence in order. By implementing this model, researcher has classified students' behavioural changes into three levels of mode as low, moderate and high which aligned with theory of behaviourism that acting, thinking and feeling can be regarded as level of behaviour. 'Low level' is identified as feeling of a person who is unaware and aware but does not engaged in sustainable lifestyles, stage 1 and 2. While, 'moderate level' is identified as thinking of a person who has an interest to engage in sustainable lifestyles but still not to contribute, stage 3,4 and 5. And 'high level' is identified as acting of a person who has contributing and practicing sustainable lifestyles as a part of their life, stage 6 and 7. Likert type scales were developed from stages of PAPM and converted into 5 scales as shown in Table 4. Three levels of behavioural changes were also determined.

Table 4, Stages and levels of Individual Behaviour Change (Weinstein & Sandman, 1988)

Stages of PAPM	Indicators of Likert Type Scales	Levels of Behavioural Change
1 Unaware of the sustainable issues	1.Unaware on issues	Low
2 Aware but not personally engaged	2.Aware on issues but not to engaged	
3 Engaged and trying to decide what to do	3.Have an interest to engage but not sure to contribute	Moderate
4 Decided not to act		
5 Decided to act but not yet having acted	4.Decide to contribute but still not to practice	
6 Acting	5. Practicing as a part of lifestyles	High
7. Maintenance		

5. Data Analysis and Results

5.1 Descriptive Analysis

Descriptive results of the survey questions are presented in Table 4. This quantitative study was conducted from September 2011 to September 2012, namely beginning of semester 1, end of the semester1 and beginning of semester 3. Statistical package PASW 18 was used to conduct statistical test. The mean scores of these responses were compared and contrasted in the analysis. The data were tested for normality where the values of skewness and kurtosis ratios are at the range between +2 and -2. The Cronbach Alpha reliability test showed an average coefficient of 0.846. With this level of reliability, all items in the questionnaire were included to obtain an overall satisfaction score of each respondent. This means that the results have a strong impact to the study.

Research Question

To what extend does CPBL could inculcate students' behaviour associated to pro-self and pro-social development in practicing sustainable lifestyles.

Table 5 presents the mean scores of students' behavioural changes on pro-self and pro-social. The mean scores on pro-self increased significantly from pre-test to post-test (M=-1.025, SD=0.771), t (119) = (-14.57), $p < 0.05$. While the mean scores on pro-social also increased significantly from pre-test to post-test (M=-1.231, SD=0.766), t (119) = (-17.61), $p<0.05$.

Table 5. Results of t-test of Significance of Differences in Test Scores

Paired Differences	t	df	Sig. (2-

		Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			tailed)
Pro-self	Before - After	-1.025	.771	.070	-1.164	-.886	-14.57	119	.000
Pro-social	Before - After	-1.231	.766	.070	-1.369	-1.092	-17.61	119	.000

5.2 Students' Behaviour Change on Self Development

Figure 2 shows the mean scores of longitudinal study on students' behaviour change towards practicing sustainable development on self development. The observation was carried out over three (3) semesters. At the beginning of semester 1 and referring to the stages of individual behaviour change (Model of PAPM) students' behaviour moved from stage 2(aware on issue but not to engage) to stage 3 (have an interest to engage on issue but not sure to contribute). Item of recycle was the highest changes compared with waste management and water conservation. While at the beginning of Year-2 (semester 3), there is no changes on waste management but slightly dropped on water conservation and recycle but still at the same stage (3). This means that CPBL with a real problem related to sustainable issues (Waste to Wealth) has significantly improved their lifestyles to be more concerned person.

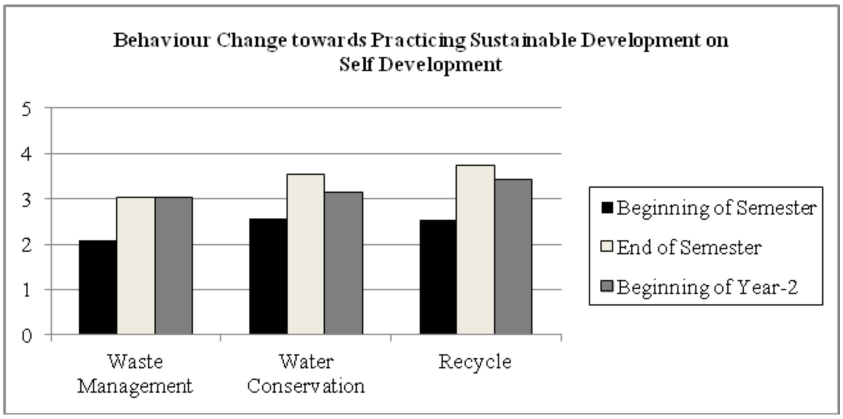


Figure 2. Students' Behaviour Change towards practicing sustainable development on self development

5.3 Students' Behaviour Change on Social Development

Referring to Figure 3, the mean scores of students' behaviour change of three items related to practising sustainable development on social development moved from stage 2(aware on issue but not to engage) to stage 3 (have an interest to engage on issue but not sure to contribute). At the beginning of semester 1, item of participate in sustainable programmes was the lowest mean score but at the end of semester 1, this items has the highest increment compared to others. Additionally, item of able to discuss with friends was the highest mean score. Similar with the results of self development, it was found that the levels of students' behaviour change dropped at the beginning of Year-2 (semester 3) and item of participate in sustainable programmes has the lowest mean score. This means that the five principles in cooperative learning have successfully developed students' skill in team working and communication. This learning environment has promoted positive relations not only among their team members but also be more cooperative among the society in discussing and participating in social programmes.

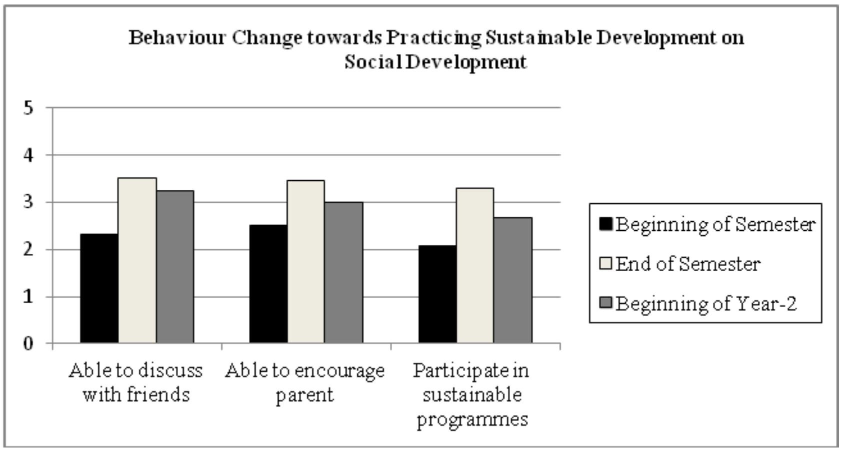


Figure 3. Students' Behaviour Change towards practicing sustainable development on social development

5.4 Students' Perception on Course Evaluation

Figure 4 shows the students' perception on course evaluation (1- strongly disagree to 5 – strongly agree). Most of the students agreed that CPBL has developed their knowledge and understanding about the importance of sustainable development, the learning environment taught them a systemic way of thinking and also conveyed them to be a sustainable person. Results that were achieved from students' behaviour change on self development showed that CPBL has developed significant positive impact on students' changes. For instance, after CPBL, students have acquired positive behaviour change especially on issue related to sustainable problem. As the problem was about 'Waste to Wealth' by applying the concept of 3Rs, item of recycle becomes the highest amongst three items of self development. It was also exhibited as the highest improvement after the course.

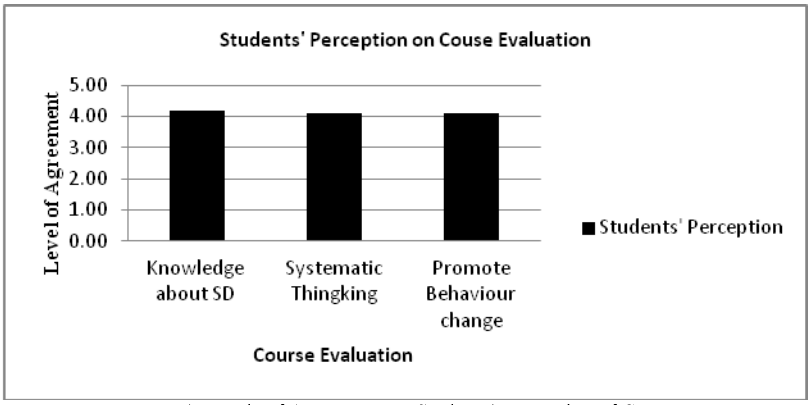


Figure 4. Levels of Agreement on Students' Perception of CPBL

On the other hand, results of students' behaviour change on social development have proven that CPBL has motivated students to learn and retain significantly more information about the issue. Through cooperative learning, students have developed their communication skill from the group interaction and work presentation. This learning environment has reformed their social skills which they could discuss with friends, able to encourage parent and willing to participate in sustainable programmes.

6. Conclusion

This study shows that the combination of CPBL as an instructional approach and a problem related to sustainable issue could promote students' engagement in behaviour change. The CPBL learning environment has positively filled in the gap between 'knowledge' and 'action'. The finding revealed that students gained deep learning from CPBL activities and increased their level of self and social development towards sustainable development. It was found that the level of students' behaviour changed in sequent at the end of semester. These findings were significantly agreed with the model of 'Precaution Adoption of Process Model' that was selected as an indicator to measure students' behaviour change. However, results of both developments at beginning of semester 3 revealed that students' behaviour change slightly declined. These findings indicated that issue on sustainable development should be continuously embedded into the curriculum for the engineering programmes. In summary, implementing CPBL as a teaching and learning approach will enhance students' learning and could transform the lifestyle of our future engineers significantly.

Acknowledgement

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References

Sharipah, N.S.S; Khairiyah, M.Y. & Azmahani, A.A (2012).Perception on Sustainable Development among new first year engineering students, , *Procedia - Social and Behavioral Sciences* 56 , pp. 530 – 536

Tamby Subahan Mohd Meereh, Lilia Halim & Thiagarajan Nadeson (2010) Environmental citizenship: What level of knowledge, attitude, skill and participation the student own? *Procedia Social and Behavioral Sciences 2*, pp. 5715-5719

N. Ibrahim & B.T. The (2011). Low Carbon Lifestyle; A Key in Moving Iskandar Malaysia Towards Low Carbon Region, *ISSM 2011*, Kora Kinabalu, Sabah, Malaysia.

Weber.N.R.,Dyehouse M., Harris C.A. David R., Fang J., Hua I. & Strobel J. (2011). First-year Engineering Students' Environmental Awareness and Conceptual Understanding Through A Pilot Sustainable Development Module, *American Society for Engineering Education.*

Felder, R. M., and Brent, R., "Cooperative Learning in Technical Courses: Procedures, Pitfalls, and Payoffs", *ERIC Document Reproduction Service*,ED 377038, 1994.

Duch, B. J., Groh, S. E. and Allen, D. E. (2001). The Power of Problem-based Learning, *Stylus Publishing*, Virginia, USA.

Boud, D. and Feletti G. (1997). The Challenge of Problem-Based Learning. *New York: St. Martins' Press*.

Tan, O. S.(2003). Problem-Based Learning Innovation:Using Problems to Power Learning in the 21st Century, *Thomson Learning*, Singapore.

Savery, J.R. (2006). Overview of Problem-based Learning: Definition and Distinction, The Interdisciplinary Journal of Problem-based Learning, Volume 1, No. 1

Woods D.R.,(1994). Problem-Based Learning: How to Gain the Most from PBL, *Waterdown: Donald WoodsPublishers*.

Mohd-Yusof, K., Helmi, S.A., Phang F. A. (2012). Creating a Constructively Aligned Learning Environment using Cooperative Problem-based Learning (CPBL) for a Typical Course, *Regional Conference of Engineering Education*, Seremban, Malaysia.

Mohd-Yusof, K., Helmi, S.A., Jamaluddin, M.Z., Harun, N.F. (2011). Creating Motivation and Engagement of Learning in the Cooperative Problem-based Learning (CPBL) Framework, *Proceeding of 118th ASEE & Exposition*, Vancouver, BC, Canada, 26 -29 June.

Mohd-Yusof, K., Helmi, S.A., Jamaluddin, M.Z., Harun, N.F. (2011). Cooperative Problem-Based Learning (CPBL); A Practical PBL Model for Engineering Courses, *Global Engineering Education Conference (EDUCON) 2011 IEEE*, Jordan

Vijayaratnam (2009). Cooperative Learning as a Means to Developing Students' Critical and Creative Thinking Skill, *Proceeding of the 2nd International Conference of Teaching & Learning* (ICTL 2009) Malaysia.

Zakaria E. & Iksan Z. (2007). Promoting Cooperative Learning in Science and Mathematics Education: A Malaysia Perspective, Eurasia Journal of Mathematics, Science & Technology Education, 3(1), pp 35-39.

Promoting Deep Learning with PBL

Gregory J S Tan

School of Health Sciences, The University of Notre Dame Australia, Fremantle, WA 6959, Australia

Abstract

The challenge in medical education is to actively involve students in learning especially in a traditional curriculum. This study introduces active learning using the principles of PBL in lectures and tutorials. The use of both task-debrief lecture and PBL were found to promote deep learning especially the latter. Deep learners were more receptive to both changes compared to surface learners who found PBL more effective in influencing their approach to learning. Despite the changes in learning approach, the student performances on case-vignette questions were not improved. The complexity of learning and the way student approaches assessment are indicated.
Keywords: Deep learning, PBL, Task-debrief lecture, Assessment

1. Introduction

University today is organically link to society and with this comes societal expectations and accountability. The needs of society and the industries have to be at the centre of a university's activities, leadership training, citizenship, competencies and others. All universities aspire for excellence in teaching, scholarship and research. For example, within the Objects of the University of Notre Dame Australia is " the provision of an excellent standard of teaching, scholarship and research". How does one measure excellence in teaching? Examination results? External ranking? Graduate attributes? Employment records?

Excellence in teaching ultimately has to be translated to "excellence in learning". There are several teaching learning models that discuss the factors that influence student learning. From their studies of educational productivity in numerous countries, Fraser, Walberg, Welch and Hattie (1987) conclude that learning is dependent upon three variables – student aptitudes (ability, development and motivation), instructions (quality and quantity of teaching) and the environment (home, classroom and peers). This is not inconsistent with Entwistle and Tait's (1989) "heuristic model" of the teaching-learning process in Higher Education which shows the complexity of the whole environment within which learning occurs (Figure 1) and John Biggs' 3-P model which states that learning outcomes are a result of the interactions of the teaching and learning contexts with the student approaches to learning (Figure 2). According to Biggs (1989), both student and teaching presage factors interact to produce an approach to learning, which produces the desired outcome of deep learning, independent learning, critical thinking and life-long learning. Lizzio, Wilson and Simons (2002) establish direct and indirect effects of good teaching on three educational outcomes (GPA, satisfaction and self reported development of problem solving and collaboration) by testing the relationship between student's chosen learning strategy and their perceptions of good teaching practices. These graduate attributes (eg. problem solving, teamwork, deep learning and critical thinking) align well with the current needs of the Biomedical Science industries, requiring students to be Biomedical Scientists rather than technologists.

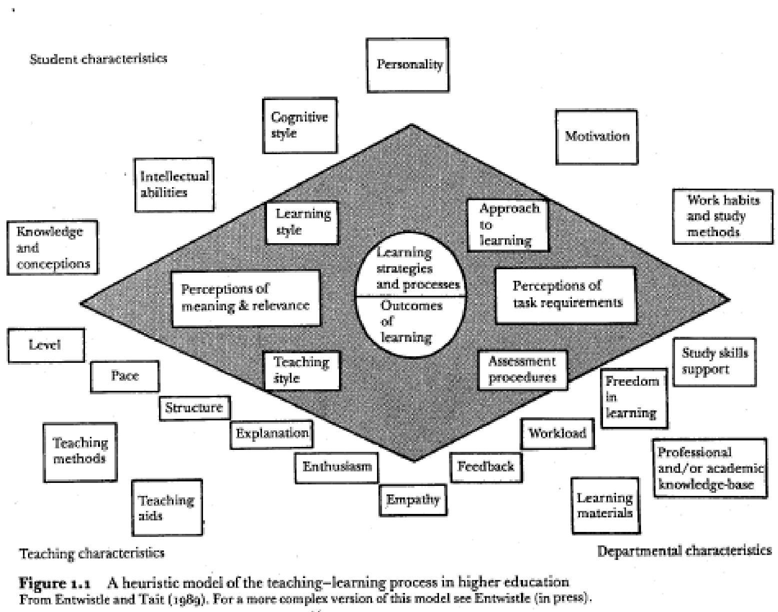

Figure 1. The heuristic model of the teaching-learning process (Entwistle and Tait, 1989). This model identifies the framework and the complexity of factors including teaching and departmental characteristics influencing student learning outcomes.

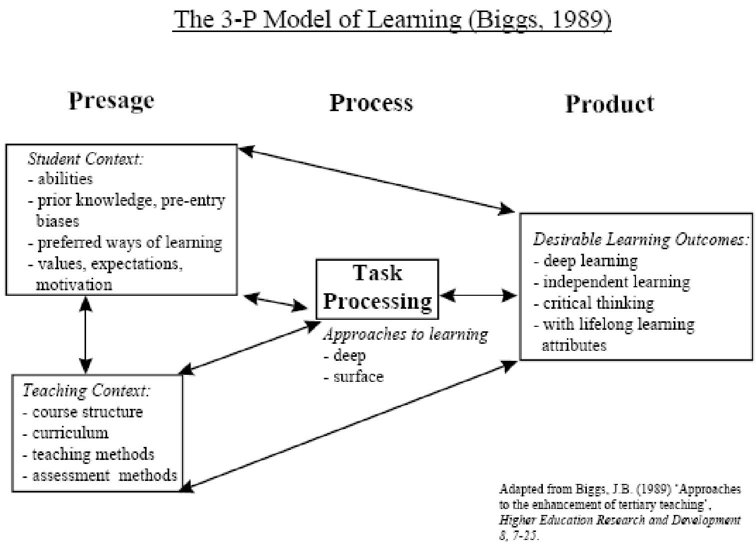

Figure 2. The 3P model of teaching and learning (Biggs, 1989) which shows the interactions of student approaches to learning with the teaching and learning contexts to produce the learning outcomes.

Based on these educational models, Universities must provide the contexts that promote deep approaches to learning and discourage surface learning if they aspire to achieve excellence in teaching and learning and produce graduates that meet the demands and challenges of the changing society and the industries.

2. Context of Research and the Research Questions

The Bachelor of Biomedical Science at the University of Notre Dame Australia is a 3-year undergraduate program. A successful completion of 24 units is required for the award of the degree. The standard mode of instruction for each unit is a 2-hour lecture followed by a 2-hour tutorial or practical session. This is practically a traditional curriculum as per mode of delivery, lectures followed by tutorials. Biomedical Science is a rapidly advancing field, especially in areas of genetics and molecular biology. The human body by itself is already complex. Often, the teaching faculties are overwhelmed by the vast amount of information and their expert knowledge and "the best approach" is to deliver them didactically through lectures. This mass "transfer of information" invariably creates rote learning and surface learners. Tutorials and practicals are more interactive (questions and answers session, test practice and hands-on activities) but albeit, insufficient to promote deep learning.

The distinction between deep and surface learning is in the depth of involvement, commitment, interaction and application. Entwistle (1990), as cited in Raaheim et.al. (1991), categorises three approaches to learning – deep, surface and strategic. Essentially, a deep approach is characterised by active engagement with the subject matter, seeking real meaning and interests. Deep learners have the ability to represent problems, integrate information, generate inferences and are problem solvers. A surface approach is characterised by memorisation of information, reproduction of facts, syllabus bound and often a lack of interest. Surface learners lack the domain-specific knowledge, fail to self-question and they spend minimum time on problem solving. A strategic approach is characterised by a student who tend to excel in assessed work with focus on effective organisation, time management and self-regulation in study (Table 1). These three approaches are of course abstractions and students may manifest a combination of these approaches to learning. What teaching strategies can be implemented to promote deep learning among students? This is the key issue and is the fundamental question of this research project.

Table 1. Categories of approaches to learning

Deep approach	Intention to understand Vigorous interaction with content Relating new ideas to previous knowledge Relating concepts to everyday experience Relating evidence to conclusions Examining the logic of the argument
Surface approach	Intention to complete task requirements Treating task as an external imposition Unreflectiveness about purpose or strategies Focus on discrete elements without integration Failure to distinguish principles from examples

	Memorizing information needed for assessments
Strategic approach	Intention to obtain highest possible grades Gear work to perceived preferences of teacher Awareness of marking schemes and criteria Systematic use of previous papers in revision Organizing time and effort to greatest effect Ensuring right conditions and materials for study

The importance of deep learning to the overall development of graduates cannot be overemphasised as they relate to leadership and competencies. The 3P model as well as the heuristic model of teaching and learning identifies several variables in the process of learning, amongst them, prior knowledge, ways of learning, motivation, teaching methods and assessments. The role of each of these variables varies. This study looks at some of these variables in relation to the fundamental question "can changes in the teaching strategies influence the learning approaches adopted by Biomedical Science students ?" Answers to this question will be used to improve teaching practice.

The participations of this project are year 3 Biomedical Science students enrolled in the unit of Reproductive Biology. The limitation of this study is in the class size (30), which unfortunately is insufficient for conclusive statistical analysis as per empirical research. Nevertheless this study attempts to contribute to the research in teaching-learning activities by investigating the following research questions.

1. What proportion of the students utilise a deep approach to learning?
2. Is there a relationship between student demographic profile and the approach to learning?
3. How effective are the changes made to the teaching strategies in promoting deep learning?
4. Is student's prior approach to learning a factor in the outcomes of the changes made?
5. Is there an improvement in the student assessment results?

3. An Overview of the Methodology

3.1. Changes to the teaching strategies

3.1.1. Lectures

The normal lectures were replaced by task-activities and a debriefing session (task-debrief lecture) for 4 consecutive teaching weeks. This effectively changed the delivery, from teacher-centred to "partial" student-centred learning. Activities included in the revised format were:

1. Identification of Prior Knowledge. Students were given a list of major topics of the lecture and asked to write down what they know.
2. Knowledge Construction. After they have identified their prior knowledge, students, in groups of 3 or 4, were asked to construct what they can learn from the resources given (diagrams, models) and identify areas that they want to learn or need to find out (learning issues).
3. Students then present what they have learned from Knowledge Construction and identify any learning issues that need to be addressed.
4. Debriefing. The lecturer then "completes" the lecture by building on what the students have constructed, "filling in the gaps" and discuss the learning issues with reference to different clinical contexts.

3.1.2. Tutorials

The normal tutorial comprises activities at different stations (gross anatomy, virtual microscopy and self-assessment). This was replaced by case-based problem-based learning (PBL) where students "brain-storm" a clinical trigger to identify the learning issues. The clinical trigger (eg. a lady with heavy menstrual bleeding) represents "the problem" the students need to solve while learning the basic sciences of Reproductive Biology. They then research the learning issues and report to the group to finally "put the cases together". This was done in a group of 10 students, for a period of 4 teaching weeks.

3.1.3. Assessment

There are two assessments in this unit, an in-course assessment and an end-of-semester assessment, each comprising multiple choice questions (MCQs) and short answer questions (SAQs). The in-course assessment was changed to align with the changes made to the lectures and tutorials. Case-vignette questions were introduced in the MCQs and SAQs which previously comprised mainly of direct-questions. Questions were asked based on "case scenario" in these questions, as a way of examining and integrating key concepts (higher level thinking skills) and thus were better questions for detecting deep approaches to learning than direct (recall)-questions.

3. 2. EVALUATION

3.2.1. Situational Analysis

Students were asked to indicate their agreement or disagreement to a series of statements that relate to their approach to learning (surface or deep) from which a 5 point Likert scale was scored (from 1 = strongly disagree to 5 = strongly agree). The statements were derived from the categories of "approaches to learning" by Entwistle (1990). Demographic profiles of the students were also obtained.

3.2.2. Changes to teaching strategies

The effectiveness of the changes to the teaching strategies was evaluated by a questionnaire survey and an assessment. Students were asked to evaluate their experiences of the changes made to the lectures and tutorials, using the same Likert scale and any additional comments. The statements were specifically designed to evaluate how the changed teaching strategies may have affected the student's approach to deep learning. An item analysis was performed to compare performances of direct questions with case vignette questions in the in-course assessment.

4. Results and Reflection

4.1. Research Question 1 and 2

1. What proportion of the students utilise a deep approach to learning?
2. Is there a relationship between student demographic profile and the approach to learning?

The questionnaire addressing question 1 contained 10 statements. Four statements related to surface learning and 6 to deep learning. A total score of 16 and above must be obtained from the 4 surface learning statements for a student to be categorised as a surface learner and 24 and above from the deep learning statements to be a deep learner. These scores corresponded to the Likert scale of "in agreement with the statement".

Based on the above criteria, 11/30 students were surface learners and 13/30 deep learners. Six students were non-classified as they had not met the total score for either surface or deep learning and no students were classified as both surface and deep learners. The different approaches to learning did not appear to relate to either the gender, student origin, age (school leavers or mature-age) or employment status (Table 2). Mature-age students are students who have left schools for at least a year prior to enrolment at the University.

Table 2**.** Demographic profiles of surface and deep learners (numbers indicate the number of students).

	Male	Female	School leavers	Mature-age*
Surface Learner	5	6	9	2
Deep Learner	6	7	9	4
Neither	3	3	4	2
TOTAL	14	16	22	8

* *students who have left schools for at least one year*

	Local	International	Work	No employment
Surface Learner	8	3	9	2
Deep Learner	9	4	10	3
Neither	4	2	5	1
TOTAL	21	9	24	6

4.1.2. REFLECTION

The total score used to identify the different approaches to learning is arbitrary but given the small number of questions, it is felt that the responses must at least be "in agreement with the statement". Entwistle (1990) categorised three approaches to learning – deep, surface and strategic and only two were used in this study. There seems to be an equal number of deep and surface learners in the student cohort. Six students were neither deep nor surface learners and none utilised both surface and deep learning. On reflection, there could be more statements to discriminate between deep and surface learners. This may account for the 6 students who were neither deep nor surface learners. They could also be strategic learners but unfortunately this group of students are not identified in the questionnaire during Situational Analysis and warrants further study.

While there appears to be no distinct relationship between the different learning approaches and the demographic profiles, this must be interpreted cautiously given the number of students (30) in this study. Biggs (1987; 1993) for instance, argued that the extent to which students have gained life experience, their prior academic ability and general intelligence may influence their learning approaches. In particular, as students get older their tendency to adopt a deep approach increases whereas their surface approach decreases and students with lower intelligence are more likely to adopt a surface approach. Again, rote study (memorisation) has been the norm in several educational systems such as the Chinese education, and students growing up in that system will invariably inherit surface learning. Even the current Western Australian school system, where progression depends on satisfying the requirements of the local Examination or School Board, does not appear to promote deep learning.

4.2. Research Question 3

3. How effective are the changes made to the teaching strategies in promoting deep learning?

Both changed teaching strategies (to lectures and tutorials) appear to have some influence on the students' approach to learning. Students felt that the introduction of activities prior to lecture debriefing promote their attention, listening, motivation, reflective thinking, use of prior knowledge, meaning to the lectures and problem-solving (mean score of 3.5 and above) but not in areas of discovery, understanding, fun or communication (Figure 3). Problem-based learning however received more "in agreement" responses and appears to be a better strategy in promoting deep learning. All areas were promoted - attention, listening, motivation, reflective thinking, discovery, understanding, prior knowledge, meaning to the lectures, fun, communication and problem-solving (mean score of 3.5 and above) (Figure 4).

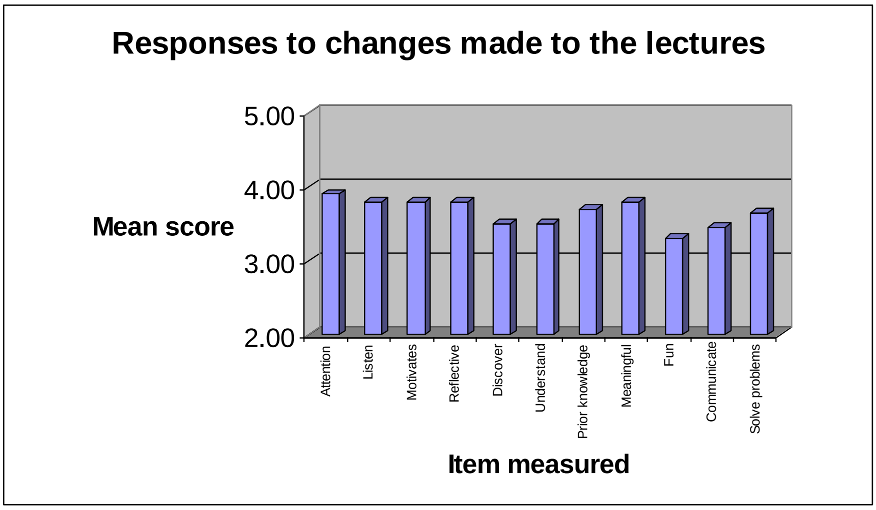

Figure 3. Students' responses to changes made to the lectures. The y-axis corresponds to the Likert scale of 2 = Disagree 3 = Not sure 4 = Agree 5 = Strongly agree. Number of respondents = 30.

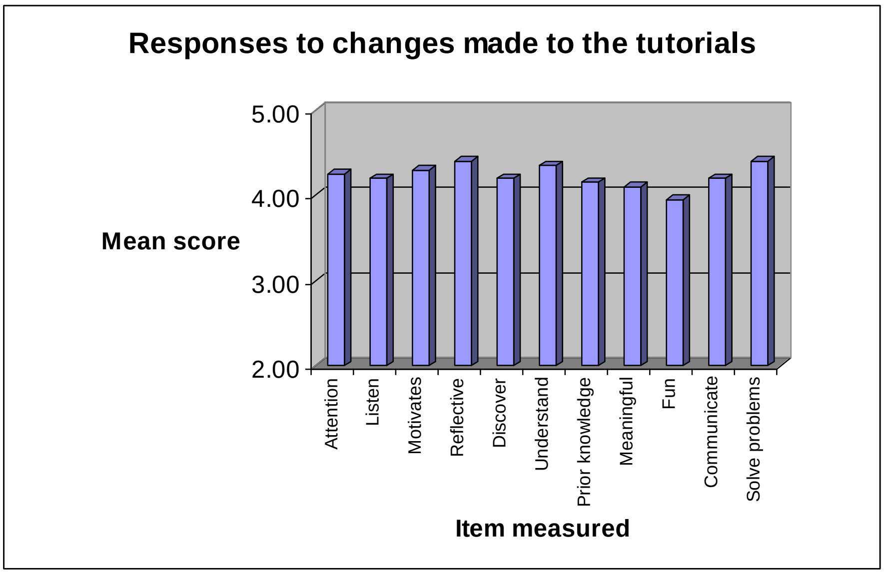

Figure 4. Students' responses to changes made to the lectures. The y-axis corresponds to the Likert scale of 2 = Disagree 3 = Not sure 4 = Agree 5 = Strongly agree. Number of respondents = 30.

4.2.1. Reflection

The statements in the survey addressing question 3 were all related to deep learning (eg. "they motivate me to listen & understand", "they make me think & relate to previous experience" and "I learn to solve problems"). They were intentionally designed to answer the question "can changes made to the teaching methods promote deep learning among students?"

It appears that both changes made to delivery have influenced the students' approach to learning and towards deep learning. This is a positive sign and suggestive of an effective intervention. What is interesting is the impact of the changes made. PBL has a greater influence than the task-debrief lectures in promoting deep approach to learning (Figure 5). This is not surprising, giving the fact that PBL is more student-orientated. While there appears to be an apparent change in the students' approach to learning in tutorials and lectures, this does not necessarily imply that the students' learning characteristics have changed. The translation of the perceived changes to a longer term effect may require a longer term intervention and reinforcements.

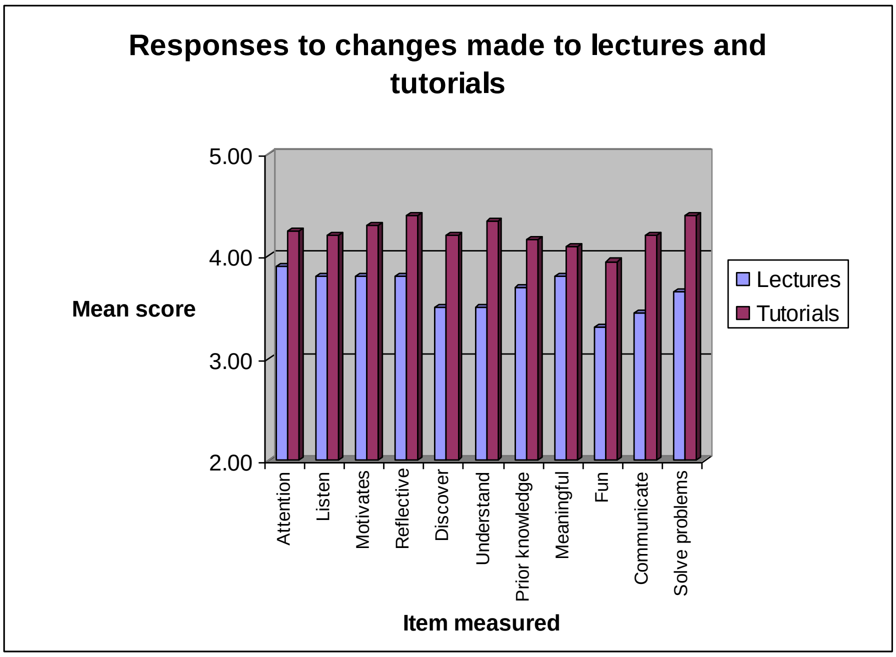

Figure 5. Students' responses to changes made to the lectures and tutorials. The y-axis corresponds to the Likert scale of 2 = Disagree 3 = Not sure 4 = Agree 5 = Strongly agree. Number of respondents = 30.

The greater impact of PBL is probably related to the nature and the clinical context of the activities. Bonanno et al. (1998) found that changes made to the learning environment which included the use of group problem solving exercises (like the present PBL), group presentations and group assignments resulted in students increasing their deep learning approach. Meanwhile, Ball

(1995) on the other hand found that applying problem based learning strategies and real life exercises can promote deep learning approaches among students.

4.3. Research Question 4

4. Is student's prior approach to learning a factor in the outcomes of the changes made?

This is more difficult to determine given the number of students (11 surface learners and13 deep learners). It appears however that surface learners are more influenced by PBL while deep learners are influenced by both task-debrief approach to lectures (prior-knowledge and knowledge construct) and PBL, with PBL being slightly more effective in promoting deep learning. The rest of the students (non-categorised) were mainly influenced by PBL (Table 3).

Table 3. Prior learning approach and impact of changed teaching strategies.

	No. of students
SURFACE LEARNERS	11
Task-debrief lecture promotes deep learning	3
PBL promotes deep learning	8
DEEP LEARNERS	13
Task-debrief lecture promotes deep learning	5
PBL promotes deep learning	8
Non-classified	6
Task-debrief lecture promotes deep learning	1
PBL promotes deep learning	5

4.3.1. REFLECTION

While deep and surface approaches characterise the way students engage with a task, they do not describe how the students develop the respective approach to learning. The latter is more difficult to address. Biggs (1989) developed the presage, process and product model that describes the process of student learning (ie. the 3P Model of Student Learning). Multiple factors interact to produce the learning outcome. Also students may use both deep and superficial learning to complete a task and to obtain the best outcome.

The results obtained in this research while preliminary support the influence of prior learning approach in developing the process of deep learning. As stated, multiple factors are invariably involved in the way students approach learning.

4.4. Research Question 5

5. Is there an improvement in the student assessment results?

Based on item analysis of all the questions (MCQs and SAQs) in the in-course assessment, the total percentage scores obtained for the SAQ direct-questions were significantly higher than case-vignette questions but not in the MCQs (figure 6). The total percentage score for the SAQ direct-questions (5) is 65.22 % and the case-vignette questions (5) 35.78 %. In the MCQs, the percentage scores for the direct-questions (5) is 72.98 % and the case-vignette questions (35) 67.27 %.

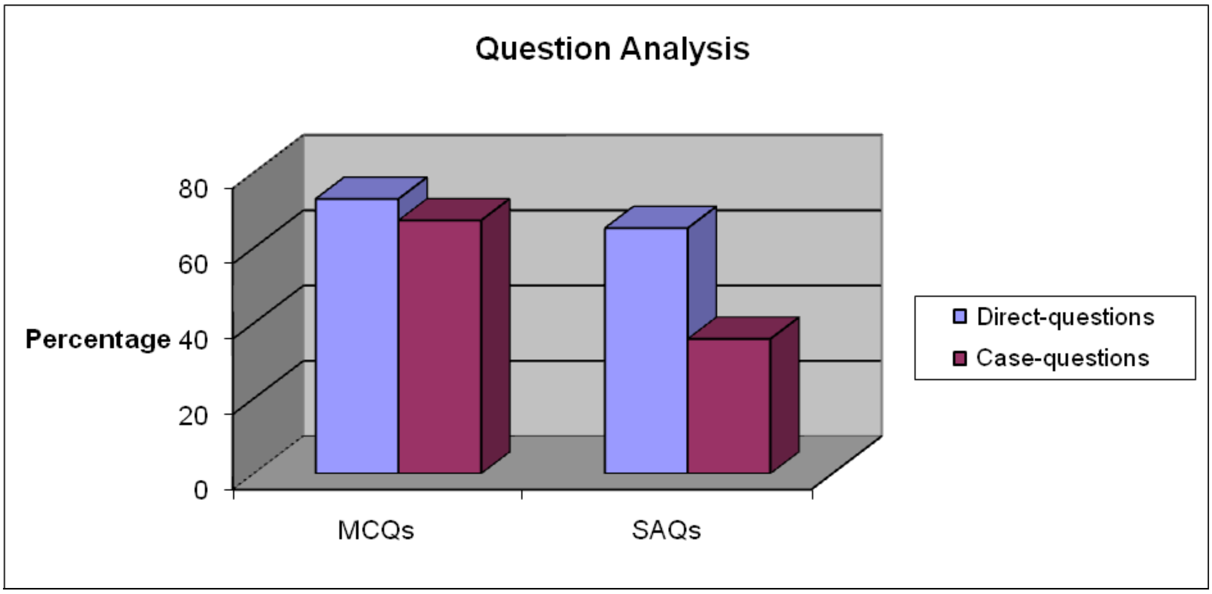

Figure 6. Total percentage mean score for MCQs and SAQs : direct-questions and case-vignette questions

4.4.1. Reflection

In previous year's in-course assessment, students tended to perform better in direct-questions than case-vignettes. The present results are consistent with this and do not show a change in the performances of the students despite the introduction of active learning in the delivery of the unit. The lower score of case-vignette question is typical of the previous year's delivery and this is more apparent in the SAQs. MCQ is an objective assessment and may not evaluate comprehension as well as SAQ.

Does this mean that the changed teaching strategies have not succeeded in promoting deep approaches to learning or that assessment is a separate entity altogether from learning approaches? Unfortunately, this cannot be answered at this stage, as it is not possible to separate the results of the deep and superficial learners as the questionnaire survey was completed anonymously. The relationship between deep learning and performances at examination is still unclear, although there is evidence suggesting that "the use of deep and strategic learning styles in the final year of medical school predicts better performance in the final examination, but the same measures at the time of selection for admission to medical school do not predict examination performance" (McManus et al, 1998)

5. Overall discussion

The results of the present study suggest that student participation in the teaching learning activities is essential in promoting deep learning. This has long been recognised (Entwistle, 2000) and is the reason for the current paradigm shift from teacher-centred to student-centred learning. The student presage (approaches to learning) and the learning environment are important contributing factors, as stated in Bigg's 3 P model of Learning. There are indications from the results of the present study to show that student's approach to learning influence the way they respond to changes made to the mode of lectures and tutorials. A strategy that is more contextual and student-directed (such as PBL) is more effective in promoting deep approaches to learning, even to surface learners. What was observed with PBL was the initial enthusiasm shown by the students as they read the clinical triggers and this somehow was lacking with the changes made to the lectures. Asking the students to search their prior knowledge and later construct knowledge appears like a chore to some students. On reflection, any changes made must be "interacting, interesting and trigger enquiries" to initiate deep learning. It was also observed that all students participated in the PBL discussion, away from the lecturer who now functions as a facilitator and is not a dominant figure. The dominance of lecturer still exists in the lecture despite the changes made. Interestingly, there are few deep learners who do not respond to the changed teaching strategies in lectures. The way students view the teaching learning activities may be an important factor. Deep learners for instance may not want to engage as deep learners if they view the lectures as "information gathering" for examinations.

Whether or not the changes obtained in the present study can be translated to long term effect is uncertain. This may be difficult as students' approaches to learning are often developed and perfected over a long period of time at school. Students often continue their mode of learning even when they enter Universities. Learning mode at school may be regarded as a model by students of successful learning at university as their academic performances have been proven by school examination and the Curriculum Council. Established habits of learning do not dissipate overnight when transit from one institution to another. Is there a tendency for students to become surface learners as they progress through their University studies?

These reservations pose a greater challenge for Universities to provide the context that promotes deep learning and cultivate students' analytical and conceptual thinking skills. Deep learning is important in the development of both cognitive (mastery of concept, applications, etc) and non-cognitive (critical thinking, metacognition, etc) effects of higher education. The promotion of deep learning is thus important and is an agenda for all Universities, not just to promote teaching excellence but also to align with the current industry needs. This above study illustrates an example of how this is being done in the lectures and tutorial sessions. The outcomes of these two teaching interventions in promoting the graduate attributes (problem-solving, reflective thinkers, etc) are congruent with the demands of the present Biomedical Science industries.

Acknowledgement

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References

Ball, S. (1995). Enriching student learning through innovative real-life exercises. *Education and Training*, 37(4), 18-26.

Biggs, J.B. (1987). *Student approaches to learning and studying.* Melbourne: Australian Council for Educational Research.

Biggs, J.B. (1989). Approaches to the enhancement of tertiary teaching. *Higher Education Research and Development* 8, 7-25.

Biggs, J.B., and Moore, P.J. (1993). *The process of learning.* (3rd ed). New York: Prentice Hall.

Bonanno, H., Jones, J. & English, L. (1998). Improving Group Satisfaction: making groups work in a first-year undergraduate course. *Teaching in Higher Education,* 3(3), 365-382.

Entwistle, N. & Tait, H.(1989). Approaches to learning, evaluation of teaching, and preferences for contrasting academic environments. *Higher Education,* 18, 1-24.

Entwistle, N. (1990, January). How students learn and why they fail. Paper presented at the Conference of Professors of Engineering, London.

Entwistle, N. (2000, November). Promoting deep learning through teaching and assessment: conceptual frameworks and educational contexts. Paper presented at the TLRP Conference, Leicester , England.

Fraser, B.J., Walberg, H.J. & Welch, W.W. & Hattie, J.A. (1987). Syntheses of educational productivity research. *International Journal of Educational Research*, 11, 145-252.

Lizzio, A., Wilson, K. & Simons, R. (2002) University students' perceptions of the learning environment and academic outcomes: implications for theory and practice. *Studies in Higher Education*, 27, 27-52.

McManus, I.C., Richards, P., Winder, B.C. & Sproston, K.A. (1998). Clinical experience, performance in final examinations, and learning style in medical students: prospective study. *British Medical Journal* 316, 345-350.

Raaheim, K., Wankowski, J. & Radford, J. (1991). Helping Students to Learn, Open University Press, Buckingham.

Evaluating potentialities and constrains of Problem Based Learning curriculum: research methodology

Aida Guerra [a] *

[a]UNESCO Chair in PBL in Engineering Education - Aalborg Univeristy, Vestre Havnepromenade 5, 1. Aalborg 9000, Denamark

Abstract

This paper presents a research design to evaluate Problem Based Learning (PBL) curriculum potentialities and constrains for future changes. PBL literature lacks examples of how to evaluate and analyse established PBL learning environments to address new challenges posed. The research design encloses three methodological approaches to investigate three interrelated research questions. Phase one, a literature review; aims develop a theoretical and analytical framework. The second phase aims to investigate examples of practices that combine PBL and Education for Sustainable Development (ESD) in the curriculum and a mean to choose cases for further case study (third phase).

Keywords: Problem Based Learning curriculum; research design

1. Introduction

Problem Based Learning (PBL) is a teaching and learning approach where solving a problem drives the learning process. Having its origin in the 60’s, PBL spread fast and several examples and its practice can be found around the world, from the compulsory education to higher education, from medicine to engineering and science. PBL is claimed as being one of the most innovative approaches, developing deep learning and competencies for professional life (Dochy et *al.*, 2003; Dolmans *et al.*, 2005)

PBL is used in professional educational disciplines as mentioned, and normally its practice is associated with curriculum change to address new challenges, like for example, engineering education to integrate Education for Sustainable Development (ESD) in the curriculum. On the other hand, one of the learning approaches claimed to integrate ESD in engineering education is PBL through, for example, the development of key competencies. However there is a lack of studies regarding in which ways PBL facilitate such curricular integration, by providing a systematic evaluation of the PBL curriculum and its potentialities to integrate sustainability aspects (Savin-Baden & Howell, 2004; Ferrer-Balas & Muler, 2005; Kolmos *et al.*, 2009; Guerra 2012).

This paper presents a research design that aims to investigate the potentialities and constrains of PBL curriculum to face new challenges, like the integration of ESD in engineering curriculum.

Figure 1 presents the overview of the research design, presenting the three research questions followed by the main methodological approaches and objectives.

* Corresponding Aida Guerra. Tel.: +45-99-40-9845
E-mail address:ag@plan.aau.dk

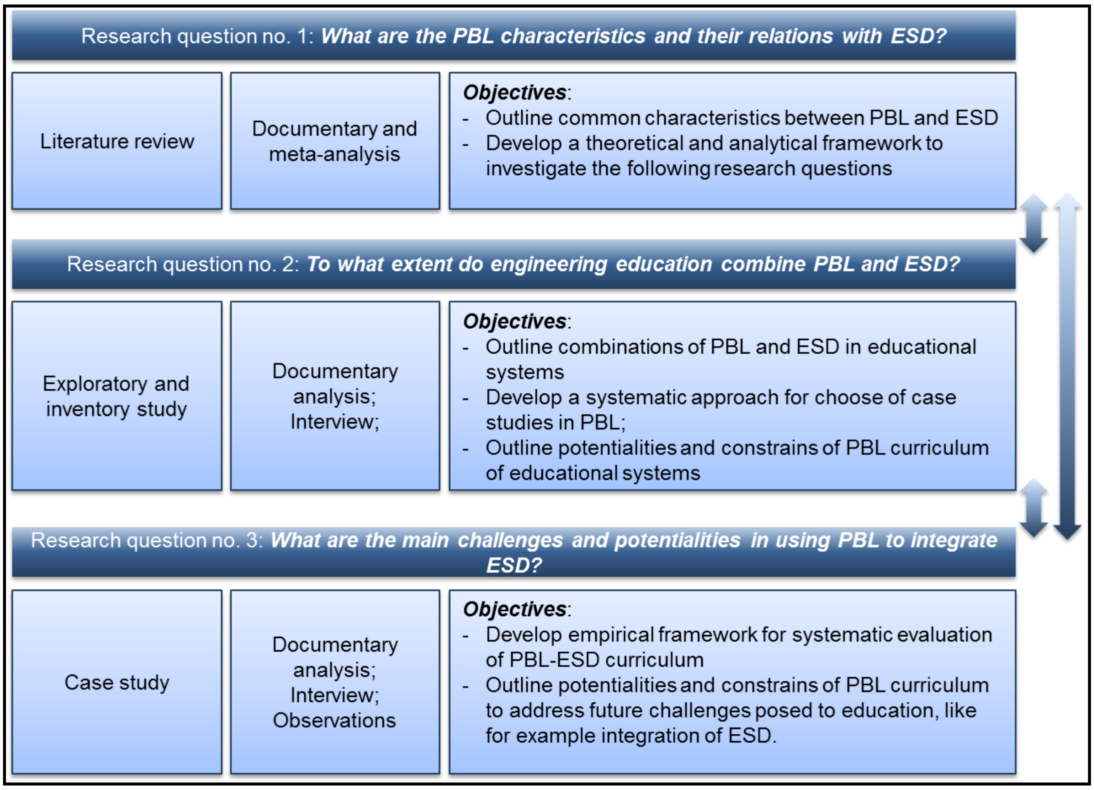

Figure 1. Overview of the research design: main research questions and methodologies

The research design has a qualitative approach and encloses three phases. In the three following sections I present each one of the phases of the research design, and their interconnections. In the third section I present some considerations of the contributions of the paper.

2. Literature review (Problem Based Learning as point of departure for the research design)

The literature review constitutes the point of departure to investigate the first research question (Figure 1). The purpose of the literature review is to provide a theoretical foundation of the alignment between PBL theory and ESD principles, and contribute for the development of a theoretical framework for data collection and analysis in the research.

Figure 2 presents the main themes literature review cover: PBL, ESD and Engineering Education. By pointing the common principles, elements and characteristics from PBL and ESD, I argue for a theoretical framework that provides the analytical elements for data collection and analysis in the research design. It is also important to stress the flexibility of the framework, due to its development in theory, which allows exploring combinations between PBL and ESD for other professional area. This framework takes into consideration the nature and the specificities of context and type of education (e.g. engineering education) where PBL is used as learning approach.

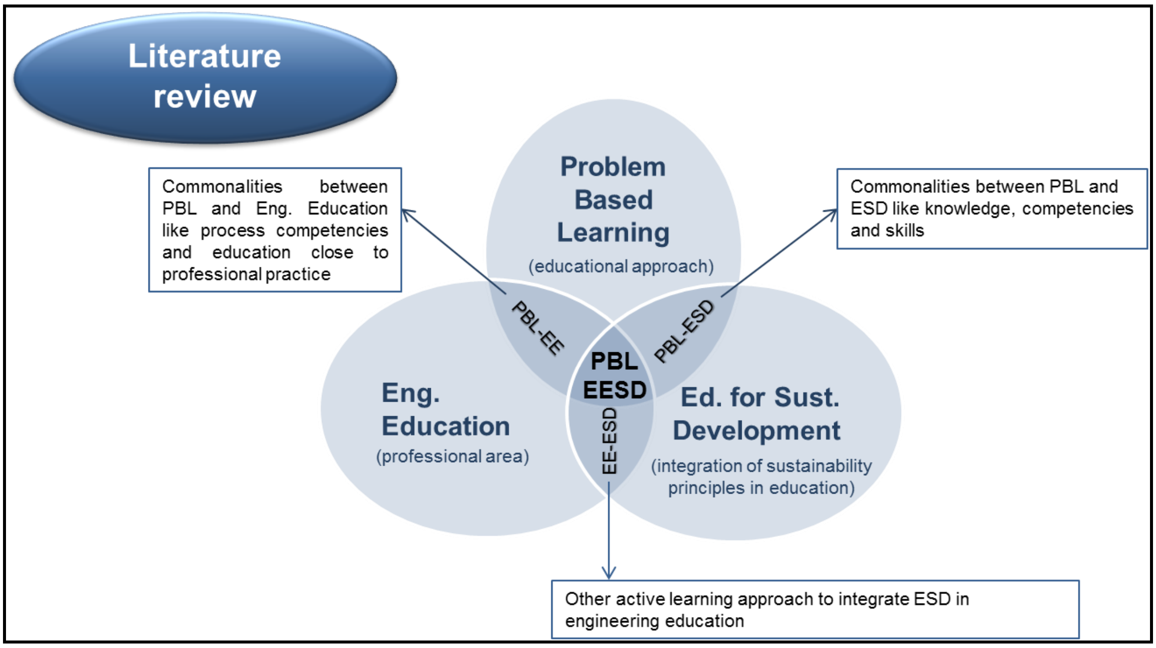

Figure 2. Overview of literature review, its phases and contributions for the research design

PBL can be seen as a learning philosophy, methodology, and/ or learning strategy. In a PBL environment, group of students analyse, formulate and solve a problem from a given real situation, which sets the start of the learning process. As a student-centred learning approach, it is up to students to, for example: (i) set a plan to solve the problem; (ii) to formulate the expected outcomes within the curriculum framework; (iii) the resources needed (e.g. bibliographic, human, facilities, etc.); (iv) assess their learning progression. Students find themselves actively involved in a learning process where they develop and apply different cognitive tasks, take responsibility for their own learning, development of several skills and competencies for life (e.g. critical thinking, long life learning, self-directed learning) (Savin-Baden & Howell, 2004; Kolmos *et al*., 2009)

PBL is a dynamic and multi variable environment, with different dimensions like: problems; knowledge; facilitators' role; students' role; assessment; learning; etc. The combination of different dimensions originates different approaches to PBL, resulting in the achievement of different learning outcomes. These dimensions provide indicators of what characterize the learning environment and the order of the learning outcomes achieve. For example the type of problem formulated, less structured; leads to the development of more complex competencies, like for example different levels of critical thinking, and different types of knowledge (Biggs, 2003; Kolmos *et al*., 2009; Jonassen, 2011).

Sterling (1996) argues that ESD should be: contextual; innovative and constructive; focused and infusive; holistic and human scale; integrative; process oriented and empowering; critical; balancing; systemic and connective; ethical; purposive; inclusive and lifelong. This is also some of the characteristics claimed to be developed in a PBL learning environment. With overlap of the elements from both worlds (PBL and ESD), it is not only possible to develop an analytical framework to evaluate the PBL curriculum, and its potentialities and constrains to integrate ESD, but also to go with the depth of the competencies developed (Table 1) (Steineman, 2003; Steiner, 2010; Jonassen, 2011).

Table 1. PBL and ESD principles

PBL elements for ESD	
Dimensions	**Categories**
Problems (Savin & Baden & Howell 2004; Jonassen, 2011)	Structured/ ill-structured; Concrete/ abstract; Practical / conceptual; Qualitative/ quantitative
Knowledge (McCormick 1997, 2004; OECD, 2000; Anderson et al., 2001; Savin-Baden & Howell 2004; Qvortrup, 2006; Kolmos et al, 2009)	Factual & Conceptual; Procedural; Metacognitive; Personal & evolutionary
Disciplinarity (Savin-Baden & Howell 2004; Davies & Devlin 2007; Bolitho & McDonnell, 2010; Borrego & Cutler 2010)	Disciplinary; Cross/ multidisciplinary; Interdisciplinary; Transdisciplinary
Criticality	Epistemological;

(Mogensen 1997; Savin-Baden & Howell 2004)	Transformative; Dialectic; Holistic
Process competencies (Sterling, 1994, 2004; Engineering Education for Sustainable Development 2004; Savin-Baden & Howell 2004; Bourn & Neal, 2008; Kolmos et al. 2009)	Problem analysis & solving Communication Collaboration Creativity and innovation
Curriculum organization (Savin-Baden & Howell 2004; Kolmos et al. 2009)	Lectures Cases Projects
Others (Sterling 1994; Bourn & Neal, 2008)	Ethics and professional responsibility
Sustainability aspects (Global Report Initiative, 2006-2011)	Environment Society Labour practices and decent work Human Rights Product responsibility Economic

The outcome of the literature review is summed up in Table 1, which presents the PBL-ESD dimensions and categories for analysis in different PBL curricula, and their interplays in practice.

3. Exploratory and inventory study

The exploratory aims to investigate the research question*: To what extent does engineering education combine PBL and ESD?*, and aims to point best examples where PBL is used to integrate ESD in engineering education. The study encloses two parts: an exploratory study followed by an inventory study (Figure 3).

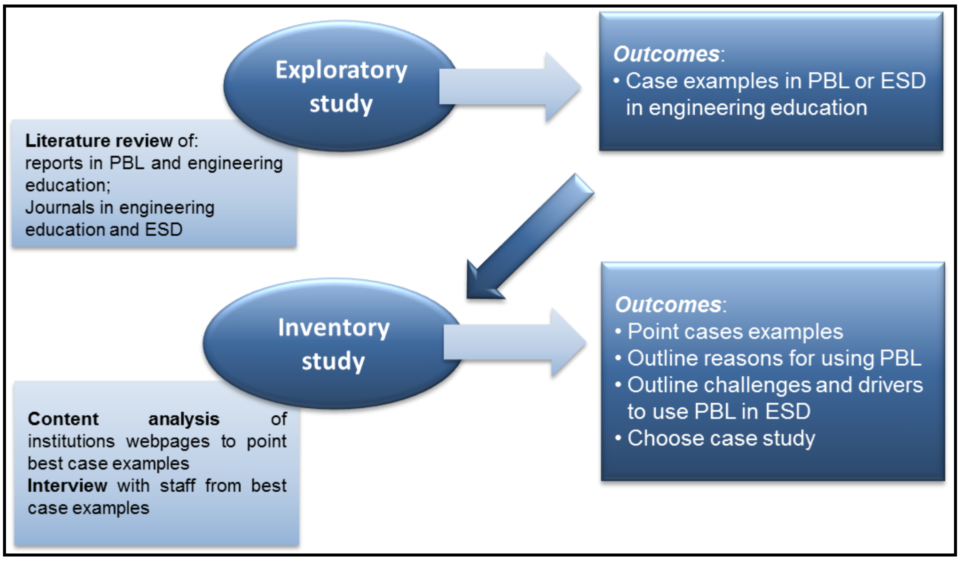

Figure 3. Overview of the research design to investigate the second research question

The exploratory study takes it part of departure in the literature review of engineering education reports, journals within area of engineering education, sustainability and PBL. Such publications report examples of PBL practice, especially in engineering education, integration ESD. For content analysis it can be used in the following indicators: problem based learning, case study, project organized learning, sustainability, sustainable development, environmental education, which correspond the dimensions presented in Table 1.

In the inventory part of the study, the institutions resulting from the exploratory study will be analysed in their homepages, programmes and syllabus. The aim is to point and select institutions that have an explicit presence of PBL and ESD in engineering education and consider them as case examples.

The content analysis is followed by interviews with practitioners from the case examples. The interview is poorly structured with open questions and aims to collect data concerning the challenges of using PBL to integrate ESD, and reasons for using it (Figure 3). These cases examples can be further used as cases for case study research, where their choice is not randomly but information-oriented (Flyvbjerg, 2006).

4. Case Study: evaluating PBL curriculum

In the case study research it is aimed to investigate the following research question: *What are the main challenges and potentialities in using PBL to integrate education for sustainable development (ESD)?*, and aims to understand, in real context, the potentialities and constrains of PBL approach to integrate ESD. The data collection targets the: (i) ESD presence in the programme (e.g. ESD principles, sustainability aspects …); (ii) curriculum organization (e.g. project organized, case study; assessment; curriculum development ...); (iii) PBL process (process competencies; challenges, problem formulation, group formation…); (iv) ESD and learning process (e.g. students motivations and perceptions; staff motivation and perceptions; etc.).

The three methods, and respective instruments, for data collection in the case study are: documentary analysis; interview and observation (Figure 4). All the data are analysed through content analysis by using the theoretical framework explained in section 2 of this paper.

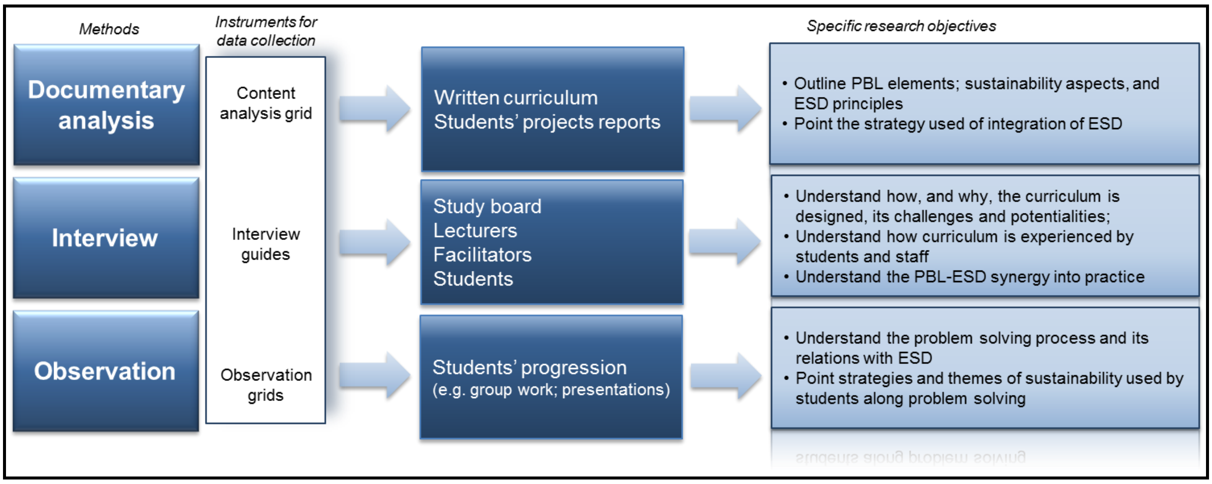

Figure 4. Overview of methods, instruments and specific research objectives for the case study research.

The data collection can be preceded as follow:

1. Documentary analysis of the curricula, which will point programmes organized around problems and with ESD presence. For this purpose, it can use the PBL dimensions and categories and sustainability aspects, presented in Table 1, as units for coding. The outcome will be mainly the development of PBL-ESD profile.
2. The same process can be used, for example, in the analysis of the students' written reports of the solving process.
3. Once the PBL-ESD profile is done, it is possible to formulate more specific questions to add to a pre-defined interview script in order to understand how this curriculum is designed and experienced by staff and students, and also to validate the PBL-ESD profile developed.
4. The interview process may include all the actors involved in the learning process (lecturers, facilitators, students) but also those who are responsible for the curriculum design (study board members). The interviews' script are constructed accordingly with the theoretical inputs from the literature review, but can be completed with more specific questions resulting from the documentary analysis.
5. The observation is non-participant, and aims to understand the learning process students are involved in, which moments characterize the solving process, where and how ESD is integrated. And like the content analysis grid developed for documentary analysis, also the observational grid contains the PBL and sustainability indicators which result from the literature review (Table 1).

The instruments for data collection and analysis have their base in the theoretical, and analytical, framework developed on the first phase on the study which allows: i) collecting systematically data from different objects/ subjects of study; ii) triangulate data from several sources; iii) collect comparable data in different type of case studies (single-case, multi-case study and/ or embedded multi units of analysis) (Creswell, 2003; Yin, 2009).

5. Final considerations

In this section I make some final considerations and reflections concerning, for example, the research design, its weaknesses and strengths.

The research design presented in this paper is qualitative, and takes its point of departure in PBL and ESD theories, with their general and abstract concepts, to case study research, with their real context of PBL practice. However the research design may go other ways. For example, the first research question formulated could start with exploratory study where PBL and ESD practice could be characterized in its elements. In this scenario, theory would support the data analysis and its interpretation, and would be more difficult to argue for generalization. On the other hand, the exploratory study could lead to some new concepts, principles, and good practices that are not yet place in the PBL landscape. Another weakness of this alternative approach is the choice of how to make the exploratory study, could this exploratory case chosen be a good example of using PBL to integrate ESD in engineering education. Of course it can be argued that there are several examples of such combinations in practice, and not necessary restricted to engineering education, but in any of the cases literature always provides good examples of practice with empirical work supporting it. That is one of the aims to be pursued with the exploratory approach (research questions number two) in the research design presented in this paper, what Flyvbjerg (2006) calls as strategic choice of case (Figure 5).

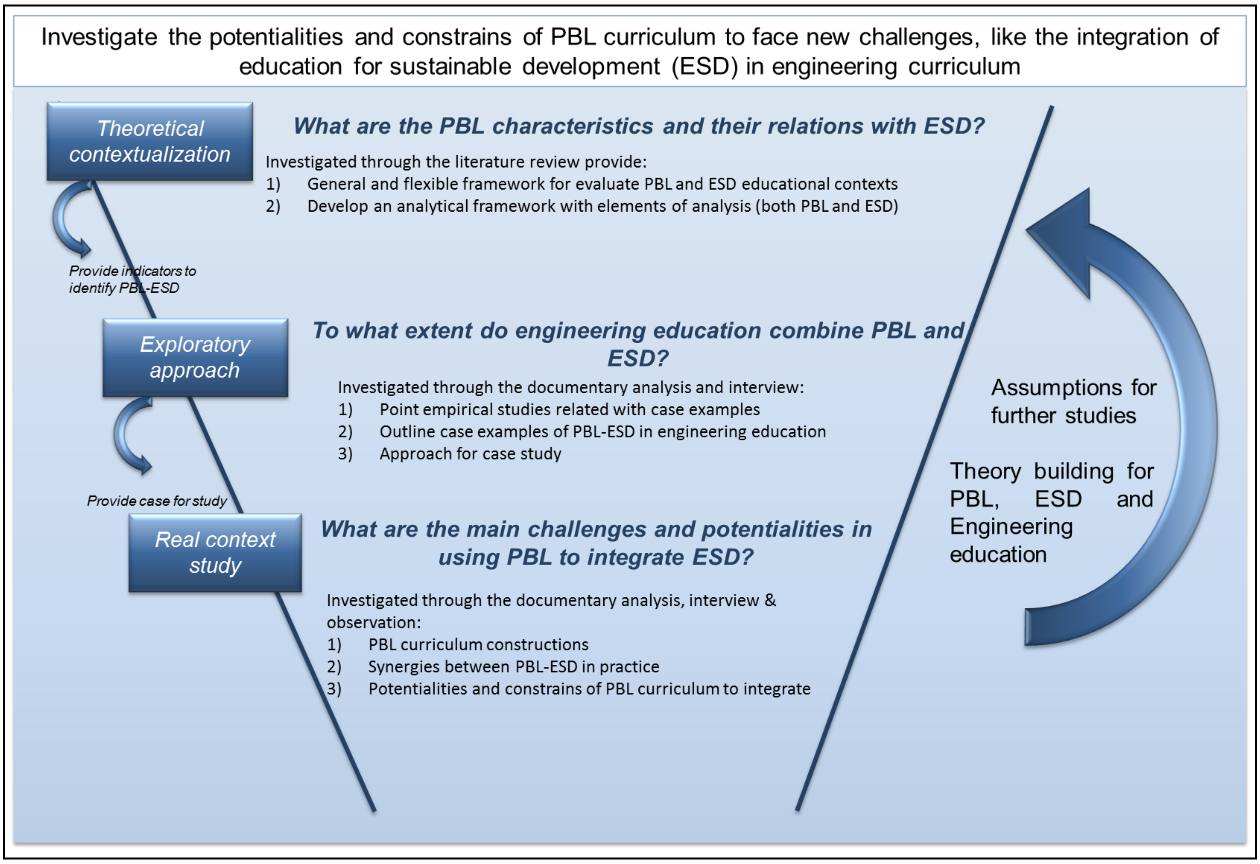

Figure 5. Holistic view of the research design

Another weakness of qualitative case studies pointed in literature is the subjectivity, related with researcher interpretation (Flyvbjerg, 2006; Yin, 2009). Using the literature approach as point of departure is one way to address this weakness by strength the systematic analysis of the cases. Literature review in the first research question allows the development of theoretical, and analytical, framework for systematic collection and analysis of data along the research process. As the process of collecting data and analysis in grounded in general principles and concepts of theory, the same analytical framework can be used cross cases that present the same conditions (e.g. PBL & ESD curriculum), and overall aims (e.g. evaluate PBL curriculum, and its potentialities and constrains for integration of ESD) for comparable studies. Also the findings from different case studies open a door for share of good practices, address challenges and enlarge new understandings of PBL community of practice (Creswell, 2003; Yin, 2009).

These are some of the considerations of the research design presented that addresses it approach, weaknesses and strengths, and more could be made. For example, this research design it may be of relevant interest of researchers in PBL and in ESD, but also to curriculum educational developers.

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References

Anderson, L., Krathwohl, D., Airasian, P., Cruikshank, K., Mayeer, R., Pintrich, P., Raths, J. & Wittrock, M. (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. Longman: New York.

Biggs, J. (2003). *Teaching for quality learning at University*. McGraw-Hill Education: Berkshire, GBR

Bolitho, A & McDonnell, M. (2010). *Interdisciplinarity in research at the Univeristy of Melbourne*. Melbourne Sustainable Society Institute. Available at: www.sustainable.unimelb.edu.au (accessed 24 September 2011).

Borrego, M. & Cutler, S. (2010). Constructive Alignement of Interdisciplinary Graduate Curriculum in Engineering and Science: An analysis of successfu IGERT proposals. *Journal of Engineering Education*, October, 355-369.

Bourn, D. & Neal, I. (2008). *The global engineering: Incorporating global skills within UK higher education of engineers*. Institute of Education – University of London: London. Available at: http://eprints.ioe.ac.uk/839/1/Bourn2008Engineers.pdf (accessed 2 September 2011)

Creswell, J. (2009). *Research Design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications: USA.

Davies, M. & Devlin, M. (2007). *Interdisciplinary higher education: implications for teaching and learning*. Centre for the Study of Higher Educatiuon - Univeristy of Melbourne. Available at: www.cshe.unimelb.edu.au (accessed at 2 September 2011)

Dochy, F., Segers, M., Bossch, P. & Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis. *Learning and Instruction, 13*, 533-568.

Dolmans, D., Grave, W., Wolfhagen, I. & Van der Vleuten, C. (2005). Problem-based learning: Future challenges for educational practice and research. *Medical Education*, 39, pp. 732-741.

Ferrer-Balas, D. & Mulder, K. (2005). Enginerring Education in Sustainble Development.. *International Journal of Sustainability in Higher Education*. 6(3), 215-315.

Flyvbjerg, B. (2006). Five misunderstandings about case study research. *Qualitative Inquiry*, 12 (2), 219-245.

Global Report Initiative (GRI) (2006-2011). *Sustainability Reporting Guidelines - Version 3.1*. Available at: https://www.globalreporting.org/resourcelibrary/G3.1-Guidelines-Incl-Technical-Protocol.pdf (accessed 20 March 2011).

Guerra, A. (2012). What are the common knowledge & competencies for Education for Sustainable Development and for Engineering Education for Sustainable Development?. Paper Accepted at SEFI annual conference, 23rd-26th Sep, 2012, Thessaloniki, Greece.

Jonassen, D (2011). *Learning how to solve problems: A handbook for designing problem-solving learning environments*. Routledge: London.

Kolmos, A., Graaff, E. and Du, X.Y. (Eds.) (2009). *Research on PBL practice in engineering education*. SENSE publisher: Rotterdam

McCormick, R. (1997). Conceptual and procedural knowledge. *International Journal of Technology ad Design Education*., 7, 141-159.

McCormick, R (2004). Issues of Learning and Knowledge in Technology Education. *International Journal of Technology and Design Education*, 14, 21-44.

Mogensen, F. (1997). Critical thinking: a central elements in developing action competence in health and environmental education. *Health Education Research*, 12 (4), 429-436.

OECD (2010). *Knowledge management in the learning society: education and skills*. Organisation for Economic Co-operation and Development. Available at: http://ocw.metu.edu.tr/file.php/118/Week11/oecd1.pdf (accessed 15 March 2012)

Qvortrup, L. (2006). *Knowledge, Education and Learning - E-learning in the knowledge society*. Samfundslitteratur: Denmark.

Savin-Baden, M. & Howell, C. (2004). *Foundation of in Problem-Based Learning*. McGraw-Hill Education: Berkshire, GBR.

Steiner, G & Laws, D. (2006). How appropriete are two established concepts from higher education for solving complex real-world problems? A comparison of Haverd and the ETH case study approach. *International Journal of Sustainability in Higher Education*, 7(3), 322-340.

Steiner, G. & Posch, A. (2006). Higher education for sustainability by means of transdisciplinarity case studies: an innovative apporach for solving complex, real-world problems. *Journal of Cleaner Production*, 14, 877-890.

Sterling, S. (1996). Education in Change. In, *Education for Sustainability*, J. Huckle & S. Sterling (eds.). Earthscan: Londo, pp.18-39.

Sterling, S. (2004). *Sustainable Education: Re-visioning Learning and Change*. Schumacher Briefing N.º 6. Green Books: Bristol

Wals, A. (2007). *Social Learning: Towards a sustainable world*. Wageningen Academic Publishers: Netherlands

Yin, R. (2009). *Case Study Research: Design and Methods*. SGE: USA

5 Ladders of Active Learning: An Innovative Learning Steps in PBL Process

Hussain Othman [a] *, Berhannuddin M. Salleh [b], Abdullah Sulaiman [c]

[a, b, c] *University Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, Malaysia*

Abstract

University Tun Hussein Onn Malaysia (UTHM) has decided since 2005 to fully implement Problem-based Learning (PBL) in teaching and learning. Since then, PBL has become the major teaching and learning approach among lecturers and students. However, some problems were reportedly faced by the students and the lecturers due to the lack of proper instruction provided for the students. A number of steps have been taken to overcome these problems. One of the main steps is to design and implement a proper learning instruction and module. The module is an innovative invention comprises a comprehensive learning system and a practical step by step learning process called 5 Ladders of Active Learning. A study was conducted on the implementation of this new innovative PBL learning process. 148 students from 4 faculties were selected to be the respondents. A set of questionnaire was developed and distributed to the respondents at the end of semester. The data were collected and analysed using SPSS application, and reported in form of mean score and percentage. Finding shows that students highly appreciate the introduction of 5 Ladders of Active Learning and it was seen as highly effective in improving their PBL learning experience. However they were also suggested that 5 Ladders of Active Learning be incorporated into a comprehensive learning system including with the incorporation of interactive learning materials and paperless learning initiative. Thus, further studies focussing on the development of a comprehensive learning system with the incorporation of interactive learning materials and paperless learning initiative is highly recommended in the near future.

Keywords: Problem-based learning, 5 Ladders of Active Learning, UTHM, Malaysia;

1. Introduction

Problem-Based Learning (PBL) is an educational strategy where learning is driven by a problem and students work in teams to learn more about the problem, conduct a research, communicate to each other, apply many essential skills and enjoy the fruits of active learning. The lecturer or teacher is not the one who controls the learning process. Instead, he or she plays the role of a facilitator and motivator to guide the students along the learning path (Savin-Baden & Major, 2004, Savin-Baden, 2003). PBL has proven to be a successful educational strategy in many different study domains all over the world and it was used as a strategy for development in the globalized higher education (Kolmos & Graaff, 2007, Du, Graaff & Kolmos, 2009). Because of its popularity, PBL has been accepted as one of the most powerful student-centered learning approaches that enable many institutions to make a significant change in teaching and learning approach. Some institutions have been successfully adopted PBL and their faculty members and students have enjoyed the benefits from the adoption.
Unfortunately, there were also some cases of ineffective PBL adoptions in which the approach was seen as incompatible, rough and burdensome to lecturers and students. The ineffective adoption of PBL has developed some bad reputations and people are stereotyping PBL into a “short cut” for easy way of teaching. PBL is seen as a fairly unstructured approach to teaching where the lecturers or teachers, after giving a problem or problems will immediately let their students work by themselves without any guidance and proper observation. That is not really a good practice and will not guarantee the successful implementation of PBL anywhere in the institution. A true PBL practitioner will always take into consideration a proper planning and they always do. Hours of up-front planning and preparation will take much of their time and energy so that what may seem to be a spontaneous student activities during PBL session are in reality a carefully planned component of a structured learning plan, with a clear educational outcomes in mind.

2. Learning process in PBL

For many years, a novice PBL practitioner will embark on “try and error” PBL exploration in which they have to face problems and challenges before finally come to the conclusion on the best PBL practice that suits their needs and the learning styles of the students. One of the most challenging parts in PBL implementation is to find the right way and proper learning process to be introduced in a selected course or topics. Many higher learning institutions have introduced their own PBL learning process and were then shared and imitated by other institutions. Unfortunately, there is no single PBL learning process that fits all. Lynda (2004) has listed more than ten PBL learning processes practiced at higher learning institutions from various parts of the world. As many years have past, the number is increasing and the PBL learning process becoming more structured and often was designed specifically to meet the demands and standard at particular institutions and for a particular subjects or courses. For instance, Temasek Polytechnic of Singapore has introduced and implemented “Seven Stages” of PBL learning process. At Republic Polytechnic of Singapore, the students solve one problem a day and the PBL process comprises three meetings for the

* Hussain Othman. Tel.: +60137792367 / +6074537933
E-mail address: hussain@uthm.edu.my

students to work together and come to the pinnacle of the PBL learning (O'Grady & Alwis, 2002). Other institutions were also having their own format of PBL learning process. Table 1 shows varieties of PBL learning process practiced at selected higher learning institutions across USA, Europe, Australia and Asia (Lynda, 2004). The learning steps in PBL process as shown in the table are between 4 to 9 steps. This does not mean that the lower is the better or vice versa. It only shows the varieties of PBL process as adopted by each institution. Some steps were common among institutions and some are unique for their own needs and learning environment.

Table 1. Varieties of PBL Learning Process

No.	Institution	Steps in PBL Learning Process
1	Faculty of Dentistry, University of Hong Kong	4
2	Gimmer University, UK, (Bachelor of Science – Mechanical Engineering)	5
3	Stanage University, UK, (Diploma in Social Work)	5
4	University of South Carolina	6
5	Samford University, USA	6
6	Lembert University, UK, (Bachelor of Engineering in Automotive Design)	6
7	Northern Arizona University	7
8	University of Sewanee, USA (Teacher Education)	7
9	Maastricht University, Netherlands	7
10	Queensland University of Technology, Australia	7
11	Mcmaster University, Canada (Chemical Engineering)	8
12	University of Newcastle, Australia, (Bachelor of Construction Management)	9

PBL is not a "one size fits all" methodology and it is more of a philosophy and approach that emphasizes the effective use of problems through an integrated approach of active and multidisciplinary learning (Oon Seng, 2003). As such, the learning process designed by any institution should reflect the integrated approach of active and multidisciplinary learning and not necessary identical from one institution to another.

3. Five Ladders of Active Learning

At University Tun Hussein Onn Malaysia (UTHM), PBL has been implemented since 2005. Since then, PBL has become a major teaching and learning approach at this institution. Some problems were reportedly faced by the faculty members regarding the selection of the most appropriate approach for them to implement PBL. Some of the trained lecturers were using knowledge and experience gained during training at institutional and national levels. Those who lack of training have to depend on their own interpretation of PBL and as a result they had developed their own versions of PBL which is in fact far from a true spirit and philosophy of PBL. Same thing goes to the students. Having meeting with many versions of PBL they have developed the sense of intimidating and frustrating. This was a common scenario occurred over times in institutions where students were not well informed, equipped and trained on how to take part in PBL learning (Barret, 2010).

Efforts have been made to overcome this problem and among which more training sessions were conducted for new faculty members. The most innovative step taken is the designing and implementation of a proper PBL learning process that truly accommodates the needs of the faculty, students and university as a whole. The PBL learning process invented in 2011 called 5 Ladders of Active Learning and was implemented as a combination with a proper learning module and system called Smart, Active and Interactive Learning (SAIL) system. Both the PBL learning process and the system were copyrighted in 2012.

While designing this innovative PBL learning process, we take into consideration some of the most important PBL cycle and course structure. Three examples of PBL cycle as shown in figure 1, 2 and 3 and discussed by Oon Seng (2003) were taken as one of the designing frameworks.

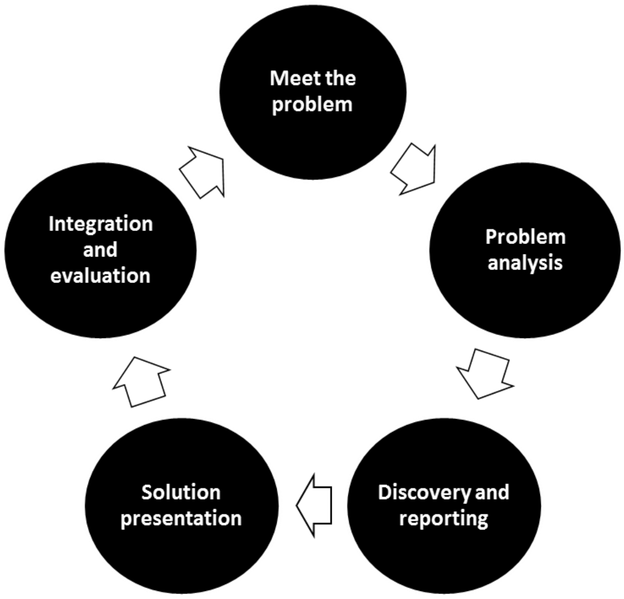

Figure 1. PBL cycle 1

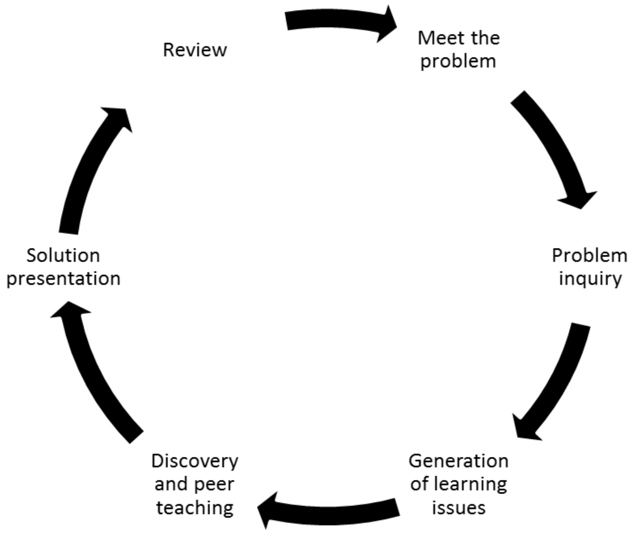

Figure 2. PBL cycle 2

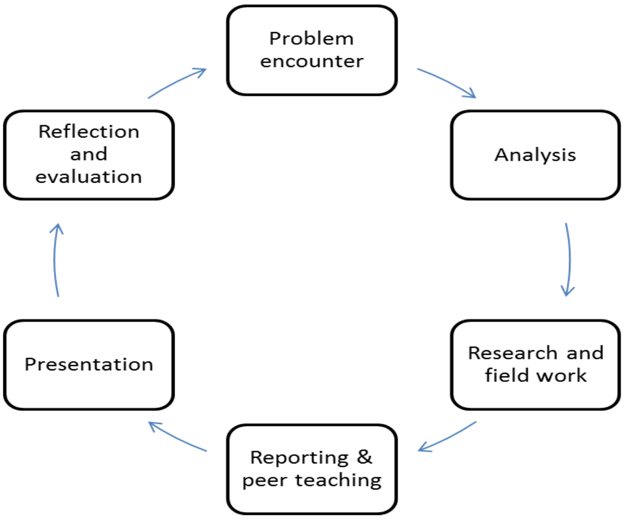

Figure 3. PBL cycle 3

Based on these three cycles, 5 Ladders of Active Learning PBL process was successfully designed. In order to ensure the successful implementation of this innovation, three other factors were also taken into consideration. First, the time frame for the whole 5 ladders to be implemented. Second, the student learning time and space, including inside classroom, outside classroom, individual learning, group learning, assisted learning and self-directed learning. Third, the type, scope, format and number of problem triggers given to the students. Reflection activity was included into each ladder as this activity is one of the most crucial stages in PBL cycle to help learners achieve optimal learning outcomes (Hung, 2006). By reflecting on the knowledge and skills they have constructed throughout 5 Ladders of Active Learning, learners have an opportunity to organize and integrate their knowledge into a more systematic conceptual framework and enhance their conceptual integration and retention of the subjects they have learnt.

In 5 Ladders of Active Learning, PBL learning starts at Ladder 1 in which the topic will be introduced to the students through a presentation of a problem scenario for each unit. The students then, work in the group to identify the learning issues using 3 Active Thinking Points (Identification of the facts, Ideas generation and Identification of learning issues). To conclude the Ladder 1 learning, the students will complete the reflection form and soon climb to the Ladder 2.

At Ladder 2, the students will have to embark on self-directed learning activities including reading the materials, watching the videos, summarizing the topic and to search for additional and supporting learning materials. To conclude the learning activities at Ladder 2, the students will have to complete the reflection form. At Ladder 3, the students will have to conduct the meeting and to report the result of their self-directed learning and prepare for the presentation at Ladder 4. To conclude the learning activities at Ladder 3 they will also have to complete the reflection form. At Ladder 4, the students will have to present their result of learning. The presentation can be in many forms. It could be a parallel presentation or a single presentation or a forum discussion. Again, to conclude the learning activities at Ladder 4, the students will have to complete the reflection form.

Ladder 5 is the final stage of learning for the topic. At this level the students will be provided with a number of proper exercises to improve their learning. The exercises can be in many forms. It could be in form of interactive Multi Choice Questions in which the students will be able to test their understanding and mastery of the topic through interactive approach. Finally, to conclude the learning activities at Ladder 5 and overall learning of the topic, the students will have to complete the reflection form. There will also be an overall reflection on the course at the end of the session. The students will have to complete overall reflection of their learning in the specific course and to answer a questionnaire set. The reflection and questionnaire set could be used by the instructors to identify the effectiveness of the overall learning as well as the module. Table 2 below shows overall learning process involved in 5 Ladder of Active Learning.

Table 2. Learning process in 5 Ladder of Active Learning

Step / Ladder	Ladder 1	Ladder 2	Ladder 3	Ladder 4	Ladder 5
Step 1	Introduction to case scenario / problem	Video input	Group meeting	Presentation	Exercises
Step 2	Identification of facts	Summary of the module	Reporting to the group	Peer assessment	Reflection on exercises
Step 3	Ideas generation	Overall module revision	Group's conclusion	Discussion	Reflection on the result of learning
Step 4	Identification of learning issues	Further self-directed learning	Presentation preparation	Conclusion	Reflection on the process of learning
Step 5	Reflection	Reflection	Reflection	Reflection	Overall reflection

Besides the fundamental challenge of designing a complete and practical PBL learning process, PBL practitioners are faced with the task of deciding how to evaluate the innovative learning process effectively and how to assess whether students have met the overall learning outcomes after going through the learning process. Main characteristics of PBL which is emphasise on the student-centered and self directed learning have created unique challenges for development of an effective assessment technique to be included in 5 Ladders of Active Learning. Two major aspects of PBL process were taken into serious consideration while designing the assessment procedure for this new innovative PBL learning process. One is the content of learning and the other is the process of learning.

Thus, this new innovative PBL learning process was completely designed with a structured assessment procedure covers both the content and the process of learning. Specifically, there are procedures, forms and rubrics designed and incorporated into the implementation of 5 Ladders of Active Learning. At Ladder 1 two set of assessment procedures were developed. One is to assess the quality of problem solving technique called FILA (facts, ideas, learning issues and action plan) and the other is a set of rubric to assess their learning reflection which is representing their mastery of learning process. At Ladder 2 and 3, there is a set of assessment procedure developed to assess students learning reflection at both ladders. This is again represents their mastery of PBL learning process. At Ladder 4, assessment procedure is using peer assessment presentation rubric. The students will be able to assess other groups during the presentation. Finally, at Ladder 5 there are two assessment procedures. First is a self-assessment instruments using multi choice questions and second is overall learning reflection procedure using specific rubrics representing the mastery of knowledge (content) and skills (process). Table 3 below shows a complete assessment procedures conducted in 5 Ladders of Active Learning.

Table 3. Assessment Procedures in 5 Ladder of Active Learning

Ladder	Assessment Procedure
Ladder 1	FILA & Reflection Rubrics
Ladder 2	Reflection Rubrics
Ladder 3	Reflection Rubrics
Ladder 4	Peer Assessment (presentation) & Reflection Rubrics
Ladder 5	Self-assessment (MCQ) & Overall Reflection Rubrics

4. Background of the study

In order to identify the effectiveness of this new invented PBL learning process, a study was conducted among 148 students from 4 faculties taking a compulsory general course at Faculty of Science, Technology and Human Development. The respondents were trained and exposed to use of 5 Ladders of Active Learning in first three weeks of the semester. Beginning in week four to the end of the semester they were actively involved in using this innovative learning process together with a learning package called Smart, Active and Interactive Learning for the specific course. Among the research questions of this study are:

1. Did 5 Ladders of Active Learning be able to create an active learning environment?
2. How appropriate the problem triggers given to the students to let them start PBL learning process using 5 Ladders of Active Learning?
3. How was the perception of the students upon the introduction of 5 Ladders of Active Learning to improve their PBL learning experience?
4. What are the skills gained by the student after participating in PBL learning activities using 5 Ladders of Active Learning?

Thus, based on the above research questions, this study is embarked in order to identify:

1. The potential of 5 Ladders of Active Learning to create an active learning environment for the students in PBL setting.
2. The appropriateness of the problem trigger given for their PBL learning process using 5 Ladders of Active Learning
3. Student perception on the introduction of 5 Ladders of Active Learning to improve their PBL learning experience
4. Skills gained by the student participating in PBL learning activities using 5 Ladders of Active Learning

This study is a descriptive study research utilizing both quantitative and qualitative data. The quantitative data was collected at the end of semester using a set of questionnaire comprises of 25 items. While for the qualitative data, the students were asked to reflect on their learning experience at the end of the semester. The qualitative data is collected in order to support the overall findings of the study. Since this research is a case study research and focusing on the experience of a group of students involved in using PBL as their learning tool, the exclusion of any respondent would certainly jeopardize the finding. Thus, all 148 engineering, technology and technical education students enrolled in a compulsory university subject from two specific classes of 2011/2012 session were selected to be the respondents of this study. The quantitative data collected was analyzed using

Statistical Packages for Social Sciences (SPSS version 13.0). The data was reported in form of percentage and mean score. The five Likert scale was summarized into three scales of "Agree" (comprises of "Extremely Agree" [5] and "Agree" [4] scales, "Uncertain" [3] and "Disagree" (comprises of "Extremely Disagree" [1] and "Disagree" [2] scales). Mean score is based on the scores between 1 (the lowest) and 5 (the highest).

5. Data Analysis and Findings

The data shows that 52.7% of the respondents (N=78) are male and 47.3% (N=70) are female. The age of the respondents is between 19 to 24 years old in which the data shows that most of them 45.9% (N=68) are 19 years old, 11.5% (N=17) are 22 years old, 6.1% (N=9) are 21 years old, 21.6% (N=32) are 22 years old, 8.1% (N=12) are 23 years old and only 3.4% (N=5) are 24 years old. Most of the respondents are from first year students which comprise of 85.8% (N=127), 7.4% (N=11) from second year, only 2% (N=3) from third year and 1.4% (N=2) from final year students.

The first objective of this study is to identify whether the application of 5 Ladders of Active Learning has led the students to learn actively? The data shows that 89.9% of respondents (N=133) agree to this statement. Ultimately this shows that this innovative PBL learning process has successfully designed for an active PBL learning environment. Table 4 below shows the percentage of respondents responded to the first question.

Table 4. Data on the first research objective

Item	Statement	% Agree (N=)	% Uncertain (N=)	% Disagree (N=)
1	I learn actively using 5 Ladders of Active Learning	89.9% (133)	8.8% (13)	1.4% (2)

Four questions related to the appropriateness of the problem triggers given for the students to start their PBL learning process were posted. First question asked whether the problems given are closely related to the learning topics. The data shows that 84.5% of respondents (N=125) agree that the problems given were closely related to the learning topics. Most of the respondents were also agree that the problems given are related to outside experiences. The percentage of respondents agreed on this statement is 85.8% (N=127). Next question related to the appropriateness of the problem given is asking the respondents whether the problems given need a serious and deeper research. The data shows that 85.2% of the respondents (N=126) agree that the problem given for them to embark in PBL learning process using 5 Ladders of Active Learning really need a serious and deeper research. Most of the respondents were also agree that the problems given are very demanding and require them to apply a higher level of thinking skills. Table 5 below shows the data related to the second objective of this study.

Table 5. Data on the second research objective

Item	Statement	% Agree (N=)	% Uncertain (N=)	% Disagree (N=)
2	Problems given related closely with the topics	84.5% (125)	12.8% (19)	2.7% (4)
3	Problems given related to outside experiences	85.8% (127)	14.2% (21)	0% (0)
4	Problems given need serious and deeper research	85.2% (126)	14.2% (21)	0.7% (1)
5	Problems given need higher thinking levels	80.4% (119)	13.5% (20)	6.1% (9)

Third objective of this study is to identify the students' perception on 5 Ladders of Active Learning after they have gone through the PBL experience using this innovative learning process. 6 questions related to this objective were posted and the data is shown in table 6 below. Based on the data, the majority of respondent view that 5 Ladders of Active Learning is positively have impact on their learning. 72.3% (N=107 and mean score) agree that this learning innovation has attracted their learning interest. Mean score recorded for this item is comparatively high (3.8041). 68.9% (N=102, mean score 3.7365) of the respondents agree that this innovative learning process is easy to follow. Most of the respondents (77%, N=114, mean score 3.9392) were also agree that this learning innovation is very effective for improving their active learning process. While 71.6% (N=116, mean score 3.8514) of the respondents agree that 5 Ladders of Active Learning is highly structured and better facilitates their group learning. Most of the respondents (81%, N=120, mean score 4.1284) were also agree that this PBL learning process is a new innovation with regards to their learning experience. Finally, most of the respondents (79.8%, N=118, mean score 4.0068) were also agree that this learning innovation is highly effective in guiding their learning process. Table 6 below listed the details of data related to the third objective of this study.

Table 6. Data on the third research objective

Item	**Statement:** 5 Ladders of Active Learning …	% Agree (N=)	% Uncertain (N=)	% Disagree (N=)	Mean Score
6	…attracts my learning interest	72.3% (107)	23.6% (35)	4% (6)	3.8041
7	…is easy to follow	68.9% (102)	23% (34)	8.1% (12)	3.7365
8	…is effective for improving my active learning	77% (114)	18.9% (28)	4.1% (6)	3.9392
9	…is highly structured and facilitates a better group learning	71.6% (106)	21.6% (32)	6.8% (10)	3.8514
10	…is a new innovation for my learning	81% (120)	14.9% (22)	4% (6)	4.1284
11	…is highly effective for guiding my learning process	79.8% (118)	14.9% (22)	5.4% (8)	4.0068

Final objective of this study is to identify skills gained by the students after they have participated in in PBL learning process using 5 Ladders of Active Learning. 14 items related to the essential learning skills and humanistic skills were listed and the students asked to give their response through 5 Likert scale. The result of this survey shows that all skills recorded higher mean scores (above 4.0). Thus, it is evidently proved that this new learning innovation had a high impact on the development of students' essential learning skills and humanistic skills.

Table 7. Mean score of students' essential learning skills and humanistic skills

Item	Skills Improved	Mean Score	SD
12	Self directed learning	4.1554	.72574
13	Group learning skills	4.2635	.66355
14	Understanding of the subjects	4.0676	.79678
15	The mastery of noble values	4.0811	.72387
16	Communication skills	4.2365	.72244
17	Team working skills	4.3446	.68723
18	Self respect and the respect of others	4.2703	.66593
19	Problem-solving skills	4.2432	.67634
20	Thinking skills	4.1757	.70678
21	Management skills	4.2162	.68552
22	Decision making skills	4.1892	.64261
23	Information management skills	4.1216	.68913
24	Life long learning skills	4.2027	.65941
25	Skills to act wisely	4.2297	.67102

6. Discussion

Finding shows that students highly appreciate the introduction of 5 Ladders of Active Learning and it was seen as highly effective in improving their PBL learning experience. However they were also suggested that 5 Ladders of Active Learning be incorporated into a comprehensive learning system including with the incorporation of interactive learning materials and paperless learning initiative. Thus, further studies focussing particularly on the development of a comprehensive learning system with the incorporation of interactive learning materials and paperless learning initiative is highly recommended in the near future.

This study has proven that a proper planning and designing of PBL learning process will ultimately bring about the successful implementation of PBL in any higher learning institution. Although most of the respondents were considered as "first timer" and lack of experience in PBL, they managed to follow the PBL learning process and be able to enjoy the outcomes of the learning. This is certainly due to a proper installation of PBL learning process through 5 Ladders of Active Learning.

The initiative behind the innovation of 5 Ladders of Active Learning is driven by the needs of the students. It was because of the difficulties faced by the students in the past to embark on PBL learning process that triggered the innovation of this PBL learning process. By taking into consideration the needs of the students and their views, this innovation is indeed following the spirit of PBL curriculum design whereby students were gradually included in the process of designing a better PBL curriculum (Hung et.al, 2007). PBL as a philosophy is itself a very powerful ideas that bring about a great change in learning and teaching perspectives among students and faculty members at higher learning institutions (Kolmos, Du, Holgaard & Jensen, 2008). The ability to develop a comprehensive model and a practical learning process would certainly be more helpful for many increasing number of PBL practitioners to implement this approach successfully at their institution. Students will also be able to follow easily the learning steps and enjoy the benefits of learning process and product along the way.

7. Concluding comments

For decades, teaching and learning process at tertiary level had been discovered to be stagnant with the over utilization of traditional lecturing approach. Knowledge, skills and values are failed to be delivered satisfactorily to the students due to the single way approach of teaching and learning which centered mostly around lecturers. Many of the public universities graduates were claimed to be passive and unable to perform their job (Singh & Singh, 2008). Failures during interview sessions surprisingly increased due to the inability of the graduates to communicate effectively and to convince the employers of their humanistic and social skills (New Strait Times, September 2 & July 22, 2009). Government as well as educationists all over the country had sensed this situation and the issues have been taken into serious consideration. The Malaysian Ministry of Higher Education (2007) for instance had requested all public universities to tackle this problem immediately through the introduction of generic skills or soft skills programs. Since then the efforts had been put into implementation accordingly. One critical way to improve the generic skills of the students is to opt for a proper approach in teaching and learning called the experiential learning in which learning centered around the students rather than lecturers. Excellent teaching and learning approach such as PBL is becoming one of the most critical success factors that a university should give more attention and focus. PBL is increasingly accepted as an active and innovative learning approach towards the development of more innovative education systems. It can be a predominant mode of learning particularly with a good planning, management support, resource allocation and staff development (Oon Seng, 2003).

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References

Barrett, Terry (2010), The problem-based learning process as finding and being in flow, *Innovations in Education and Teaching International*, Vol. 47, No. 2, 165–174.

Du, Xiangyun, Erik De Graaff, Anette Kolmos (2009). PBL – Diversity In Research Questions And Methodologies, In *Research on PBL Practice in Engineering Education,* Sense Publishers, 1–7.

Fewer unemployed graduates expected, New Strait Times report, a Malaysian news paper, 22 July 2009.

Graaff, Erik de (2004), "The Impact of Assessment on the Problem-based Learning Process", ins. Maggi Savin-Baden & Kay Wilkie, *Challenging Research in Problem-based Learning* (eds.). Berkshire: Open University Press., 26-36.

Graduates: too choosy about job, New Strait Times report, a Malaysian news paper, 2 September 2009.

Hung, Woei (2006). *The 3C3R Model: A Conceptual Framework for Designing Problems in PBL,* The Interdisciplinary Journal of Problem-based Learning, Volume 1, no. 1, Spring 2006.

Hung, Woei, David H. Jonassen, and Rude Liu (2007). Problem-Based Learning, ins. J. Michael Spector et.al., *Handbook of Research on Educational Communications and Technology*, Routledge, 486-506.

Kolmos, Anette, Xiangyun Du, Jette E. Holgaard & Lars Peter Jensen (2008), *Facilitation in a PBL Environment,* Center for Engineering Education Research and Development, Aalborg University.

Lynda, Wee Keng Neo (2004). *Jump Start Authentic Problem-Based Learning.* Singapore: Pearson-Prentice Hall.

Ministry of Higher Education Malaysia, Humanistic Skills Guidelines, 2007.
O'Grady, Glen. & Alwis, W.A.M. (2002). 'One-Day, One-Problem: PBL at Republic Polytechnic'. Paper presented at the 4th Asia Pacific Conference on PBL, hosted and organised by Prince of Songkla University, 9–13 December, Haadyai, Songkhla, Thailand.
Onn Seng, Tan (2003). *Problem-Based Learning Innovation: Using Problem to Power Learning in the 21st Century.* Singapore: Thomson.
Savin-Baden, Maggi & Claire Howell Major (2004). *Foundations of Problem-based Learning.* Berkshire: Open University Press.
Savin-Baden, Maggi (2003). *Facilitating Problem-based Learning: Illuminating Perspectives.* Berkshire: Open University Press.
Singh, Gurvinder Kaur Gurcharan & Sharan Kaur Garib Singh (2008). Malaysian Graduates' Employability Skills, *UNITAR e-Journal*, Vol. 4, No. 1, 15 – 45.

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CRAFTING A GOOD PBL SCENARIO IN COMPANY SECRETARIAL PRACTICES COURSE

Nor Aziah Abdul Manaf[a*] , Zuaini Ishak[b], Zahyah Hanafi[c], Sopia Md Yassin[d]

[a] Universiti Utara Malaysia, School of Accountancy, 06010 UUM Sintok, Malaysia [b] Universiti Utara Malaysia, School of Accountancy, 06010 UUM Sintok, Malaysia [c] Universiti Utara Malaysia, FSKP Building, 06010 UUM Sintok, Malaysia
[d] Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Malaysia

Abstract

The objective of this paper is to disseminate the relevance of PBL approach in classroom teaching and how instructors craft/design real workplace scenarios. PBL has been claimed as an approach that incorporates multi-level skills, higher order thinking and generate discussion, exploration and interest in learners. In order for these learning processes to occur, instructors need to know and understand the underpinning of what constitutes a good and effective PBL scenario. Thus, this paper highlights the intricate process of what elements instructors need to consider when crafting the scenario: know the level of knowledge to be learnt, identify types of problems appropriate with the course content, refer to a review checklist, and able to differentiate between good and bad scenario. Finally, a sample of a good scenario is presented, together with learning outcomes, prior knowledge, duration of task, FILA chart, and assessment plan.

Keywords: PBL scenario, crafting problem, teaching approach, good PBL problem

1. Introduction

One of the key elements to an effective use of PBL in the classroom is to create an authentic problem scenario. Crafting a problem scenario is a complex and multifaceted issue with very few direct answers due to the difference in the nature of knowledge and how the knowledge is to be applied. However, considerations should be given to the type of problems based on the different levels of a course and the types of questions that learners are required to engage students' curiosity and initiate learning the subject matter while solving or managing the problem (Nor Aziah, Zuaini & Wan Nordin, 2011).

Schmidt and Moust (2000) suggested an approach to problem design by taking into account the different types of knowledge that learners need to acquire in a program. From this perspective, different types of problems are identified to guide learners towards the development of that particular type of knowledge. This approach is helpful in the initial stage of problem design. By identifying the types of knowledge to be learnt, the problem can be more focused. The Taxonomy on the types of knowledge and the different types of problem that require the application of those different types of knowledge is shown in Table 1.

Table 1: Types of Knowledge and Problem

Type of knowledge	Goal of the knowledge	Type of problem	Example of type of question
Descriptive knowledge	Acquire knowledge about facts	Fact-finding problem	What are the facts?
Explanatory knowledge	Acquire knowledge on why something occurs (such as the cause of it happening)	Explanation problem	Why did it occur?

* Corresponding Author name. Tel.: +6-012 4015200
E-mail address: aziah960@uum.edu.my

Procedural knowledge	Acquire knowledge to act upon the situation in order to change it	Strategy problem	What steps should be taken? What would you do?
Personal knowledge	Acquire knowledge to examine and understand personal conviction or attitude	Moral dilemma resolution problem	What would/should you do in a dilemma situation?

Source: Temasek Polytechnic (2006)

Although the above given guideline is very useful, however, common principles for effective problem design based on the different types of knowledge are not independent of each other. For example, learners are assumed to have acquired an understanding of either descriptive or explanatory knowledge or both to respond effectively to both procedural and personal knowledge.

Besides taking into consideration the types of knowledge and types of question, there are also common principles or guidelines for effective design of problems (Temasek Polytechnic, 2006; Savin-Baden & Howell-Major, 2004; Dolmans & Snellen-Balendong, 1997; Barrows, 1994). Essential elements for crafting effective PBL scenarios are real life, relevant and authentic; acquire new knowledge; stimulate elaboration and higher order thinking; generate learning issues; engage discussion and exploration; integrate other disciplines; outcome based; realistic process; deliverables; and resources.

The elements described above in reviewing a problem scenario, is presented in the form of a checklist (Table 2) as a guideline to ensure the crafting of effective scenarios.

Table 2: Problem Scenario Review Checklist

Essential Elements of Good Problem Scenario

Real life, relevant and authentic
- Presented as it would be in the real world.
- Relevant to the learners' future profession.
- Reflect contemporary situations of interest to the learner.
- Exhibit the experiences and skills required in the workplace.
- Occur frequently in real life.

Acquire new knowledge
- Create seed of interests and roles that learners can relate.
- Apply prior knowledge in understanding the problem.
- Trigger learners to acquire soft skills.
- Engage learners to discover new knowledge.

Stimulate elaboration and higher order thinking
- Encourage HOTS through cues.
- Require extended inquiry.
- Provide sufficiently enough information.
- Sufficiently open ended.
- Not limited to one single correct solution.
- Evaluate solutions and justify all decisions.
- Begs for action or resolution.

Generate learning issues
- Encourage learners to identify multiple learning issues.
- Allow exploration of ideas.
- Not too directive or too structured.

Engage discussion and exploration
- Stimulate learners to be curious and investigate further.
- Encourage learners to function as a group.

Integrate other discipline
- Promote integration of multi disciplinary area.

Outcome base
- Address the intended outcome of the course/programme.
- Written at an appropriate learning level.

Realistic process
- Realistic in terms of timing/independent study/research.

Deliverables

- Specify realistic and feasible deliverables.
- Present in a clear and coherent manner.

Resources

- Adequate and accessible resources.

Designing a good problem scenario is not an easy task. A well design, well-structured, open-ended, real-life, engaging problem forms the core of a PBL curriculum. A problem that is poorly design does not encourage an inquiry process and inhibits the attainment of the learning outcome. How should problems be crafted to optimize student learning using the PBL approach? The dilemma in crafting problems is well discussed and documented by Margetson (1987:155).

"The form of a question is superficially that for which draws attention to something not known or to something which might not be known. It points, as it were, to an outcome space or an answer space, while leaving the content of that space open".

Good and bad problem scenario is differentiated in below (Table 3).

Table 3: Good and Bad PBL Scenario

Good Problem	Bad Problem
Growing web • complex and indeterminate • problem and context inseparable • space for growth	Convenient peg • arbitrary • problem is subordinated to knowledge transfer • test of strength
Question in question form • What is time? • Concept and value orientated • No right answer • Neither tutor nor student knows the answer	Question in statement form • What is the time? • Content orientated • A single right answer • The tutor knows the answer

Source: Margetson (1987:155)

2. Presentation of Problem

The problem scenario can be presented in different format. The scenario need not necessarily be in the form of a problem that needs solution. Clarifying a phenomena, challenge, dilemma, difficult concept, designing or creating something, new ways of doing things, and triggers can also be a problem. According to Mauffette et al., (2004:11), two characteristics namely variety and challenge are very important in a good problem design. Problem designers need to devote considerable time and thought on the problem format. Ideas for crafting scenarios can come from anywhere. Nor Aziah, et al. (2011) interviewed the CEO of a halal food manufacturing and distributing enterprise and visited the plant to reflect the real halal food manufacturing business in crafting the problems. Listed below are various format for presenting different problem scenarios.

dialogues	posters	reflective journal
cartoons	songs	diary entries
diagrams	letters	memos
dilemmas	audio-tape recordings	e-mails
newspaper articles	video clips	photographs
minutes of meeting	quotations	

Sole reliance on a particular format may have dysfunctional consequences for the learner (Bransford, et al., 1989). Various modalities in presenting the problem will benefit learners and prepare them to deal with real problems through perceptual learning as this allow learners to recognize not only verbal, but visual, auditory or non-verbal cues. Since PBL curriculum prepares learners for professional practice, the problem should be presented in a format that resembles the actual workplace practice (Wee, 2004).

In PBL, the problem functions as a trigger that drives learning. The ability to craft good quality problem scenario is a critical skill for the PBL facilitator. The next section presents an example of how problem in a company secretarial practices course is crafted.

3. PBL Scenario in Company Secretarial Practices

The scenario crafted covers the company secretarial practices topics that are generally taught at the accounting undergraduate level. The issues highlighted in the scenario are frequently discussed, and by creating such scenes will help learners further understand the underpinning principles embedded in these scenarios. There are two emails in this task. In the first email, Imran informed Taufiq of what transpired during their 'teh-tarik' sessions. They have decided to venture into business. Fitri's uncle suggested they become his teak furniture distributor in Kuala Lumpur while Harith feels strongly towards starting his own workshop with his friends. At the moment, they cannot decide which business to take up. The more pressing concern is whether the proposed business should be set up as a partnership or a company. Therefore, Imran wants Taufiq to explain to the others the reasons why it is better to set up a company rather than a partnership. In the second email, the group has decided to set up a company instead of a partnership. Imran requested Taufiq to explain the procedure of setting up the company and help him to prepare the required documents to be submitted to the Companies Commission of Malaysia (CCM).

Item 1: Title of Problem – *Catchy, Keep It Short and Simple*

Teh Tarik Chatterbox

Item 2: Problem Scenario – *well structured/contextual-relates to everyday life/professional life of learner/authentic/engage learner; 4 characteristics-hook/context/content/form; variety of stimulus-memos/cartoons/dialogue/etc.; include graphics/photos wherever possible.*

E-Mail 1

Inbox: Need your help (1 of 50) Move | Copy Trash

Delete | Move to Trash | Reply | Reply to All | Forward | Redirect | Blacklist | Message Source | Resume | Save as | Print Back to Inbox

Date: Mon, 19 September 2011 14:03:32 +0800

From: imran@uum.edu.my

To: taufiq@yahoo.com.my

Subject: Need your help!

Hi Fiq! How are you? It's been a long time since I last heard from you. Last week, I met Daniel, your ex-roommate. Still remember him? He's now working with MARA. I went to an entrepreneur seminar handled by him. He told me that you are now a successful company secretary. We're so proud of you, Fiq. You're so fortunate, as compared to some of our friends, including me, Ahmad, Fitri and Harith. We are still looking for opportunities for a better future. At this moment, Fitri and Harith are between jobs. We met a few times before for 'teh-tarik' sessions and after a few discussions, actually we are thinking of running a business. Fitri said he has an uncle in Jakarta, who owns a teak furniture factory. So the uncle suggested us to be his distributor in KL. Ahmad seems very excited about this idea. But Harith has something else in mind. He prefers to operate a workshop since he has vast experiences working with EON Services. He knows many mechanics, so he thinks he'll be able to persuade them to work in the workshop. We are still undecided on this, anyway I don't think this is an urgent matter.

Since you are the expert, I really want to ask your opinion. Ahmad wants to set up an enterprise or partnership because he thinks that the procedure is simple and less money needed. Fitri and Harith don't really care what type of business entity to set up as long as it can be operated as soon as possible. But I prefer to form a company – so I can become a so-called managing director. Sounds glamourous, isn't it? Anyway, personally, I think incorporating and running a company is not very difficult. What do you think?

Daniel also mentioned to me about this new scheme for SMI entrepreneurs. They offer financial assistance to entrepreneurs who are interested. They also offer business premises in Kepong area at a very low rental rate. However, the application to join this scheme should be submitted before 24 October 2011. We are short of time now if we want to grab this opportunity. After all, we also need to apply for a loan to start up our business since each of us can't contribute much. However, we don't have a business entity yet!

We plan to meet for our next 'teh-tarik' session this Friday to decide on the business entity. I really want to convince those guys on incorporating a company instead of setting-up an enterprise. Any tips?

Okay Fiq, I really hope to hear from you soon…very soon, and I mean before this Friday… hehe… I wish you could join us for the "teh-tarik"... but I know you are a busy businessman. Next time, I'll let you know in advance. Anyway, I really hope you can provide me with some information so that I can show and explain to those guys.

Oppss!! I have one more thing here, during the seminar we were also told that the Companies Commission of Malaysia (CCM) had proposed a new concept of "Limited Liability Partnership (LLP)", but the concept was not explained due to limited time. I just wonder why the CCM wants to introduce this concept.

Till then…

Imran

E-Mail 2

Inbox: RE: Need your help (1 of 60) Move | Copy This message to

Delete | Move to Trash | Reply | Reply to All | Forward | Redirect | Blacklist | Message Source | Resume | Save as | Print Back to Inbox

Date: Mon, 26 Sep 2011 8:03:32 +0800

From: imran@uum.edu.my

To: taufiq@yahoo.com.my

Subject: RE: Need your help

Fiq,

Thank you for your prompt reply. It definitely shows how efficient you are as a secretary. Everything is always at your fingertips. And thanks again for all the information you've shared with me. It benefits me a lot. I even shared your info with the others. Your detail explanation manages to assist us in deciding which kind of business should be chosen. After thinking in depth and having long discussion we agreed to incorporate a company rather than partnership. I'm so excited about this. We think by hiring a company secretary we will have no problem in incorporating the company. You know what, they've agreed to appoint you as a company secretary!!! So, can we assume that you accept this appointment because we don't want to find an unknown company secretary to help us? We'll be more comfortable if you're our company secretary.

For your information, we've decided to run a furniture business as we think it has better prospects. Hope you can make all the arrangements to incorporate the company for us. If you don't mind, could you please prepare the documents ASAP since we're still hoping to get the financial assistance offered for SMI entrepreneurs? I was told by Daniel that the process will take about 2 weeks to have the Certificate of Incorporation. Hmmm.... I hope to get some ideas from you on the procedures to incorporate a new company. Really appreciate if you were able to start preparing all documents needed to incorporate the company for us.

Fiq, I think I've to stop here for now.

Hope to hear from you soon. Thanks again for helping us out.

Looking forward to have "teh tarik" together ☺. Regards,

Imran

Item 3: Learning Outcomes – *Encompasses the 3 domains; Follow MQA guideline-explicit, measurable, and achievable; arrange according to the cognitive, psychomotor and affective domains.*

Learning Outcomes

At the end of the task, learners are able to:

1. Compare and contrast the types of business entities: business firm, registered company, and Limited Liability Partnership (LLP).
2. Describe the legal and general procedural requirements on the registration of companies.
3. Prepare the incorporation documents as required by the Companies Act 1965 and Companies Regulatio 1966.
4. Differentiate formal and informal written report.
5. Collaborate effectively as a team.

Item 4: Prior Knowledge – *All related concepts and skills acquired including tacit knowledge.*

Prior Knowledge

Company Law, Type of Businesses in Malaysia

Item 5: Duration of Task – *The time taken to complete the PBL process.*

Duration of Task

The duration for the tasks is 3 weeks in total. Subcomponents of the tasks are as follows:

Task	**Duration**
Reply E-mail 1	3 days
Reply E-mail 2	3 days
Name Search:-	3 days
- Form 13A	

(Note: The facilitator acts as the CCM officer in approving the

name search)
Lodge incorporation documents:-
– Memorandum of Association 7 days
– Articles of Association
– Form 6 and Form 48A
(Note: The facilitator acts as the CCM officer in issuing the Certificate of Incorporation)
Lodge documents after incorporation 4 days
– Form 24, 44 & 49

Item 6: Deliverables – *The output of PBL task in the form of lab report, group presentation, reflective journal, learning log, written report, models, quiz, etc. Deliverables can be submitted individually/pair/group etc.*

Deliverables

Learners are introduced to the problem by sending them e-mail 1. E-mail 2 will be forwarded after the learners have replied to e-mail 1. As a group, learners need to reply the two emails and prepare all documents and forms required by law in incorporating the company under the Companies Acts 1965.

Item 7: FILA Chart – *The content in relation to the learning outcome, it also includes the action plan to be taken in the process of solving the problem.*

Facts	Ideas	Learning Issues	Action Plan
Information extracted from the problem scenario. Grouped according to theme, wherever possible.	*Possible causes/effects/ideas/solution. Based on facts identified. Accepted without judgment. Evolves over time.*	*Phrased as questions. Answer should contribute towards solving the problem. Generate 5W and 1H questions.*	*Activities to be carried out to answer gaps in order to help solve the problem e.g. conduct research, interview.*

FILA Chart

E-mail 1

Facts	Ideas	Learning Issues	Action Plan
Imran and his friends wanted to operate a business. Ahmad wants to set up a partnership. Fitri and Harith do not really care what type of business entity. Imran prefers to form a company. Taufiq needs to reply email within 3 days. They wanted to apply for financial assistance under SMIs.	There are pros and cons for each business entity. Partnership is easier and cheaper to form than corporation. Company secretary is needed as soon as possible to set up a business. Funds offered by SMIs scheme is only for a limited time. LLP is a new type of business, which is better than	How different is a partnership compared to a registered company? Which type of business is more suitable for the group? Why? What is the concept of LLP?	Find information about business entities in textbooks and internet. • Search information on LLP. Search information from CCM website. Call CCM to assist in getting information.

• Imran wants to know about LLP.	partnership		

E-mail 2

Facts	Ideas	Learning Issues	Action Plan
Imran and friends decided to run a furniture business. They wanted to incorporate a company. They need ideas on the procedure to incorporate a new company. They decided to appoint Taufik as the company secretary. It takes about 2 weeks to obtain the Incorporation Certificate.	Forms must be submitted to incorporate a company Payment must be made to incorporate a company. Legal procedure must be followed to incorporate a company. A company secretary must be hired for incorporation.	What are the legal and general procedural requirements to register a company? How do you apply legal and general requirements when setting up a company? What are the documents needed to incorporate a company? How do you prepare the documents needed for incorporation?	Find information on legal and general procedural requirements from textbooks, Companies Act 1965 and internet. Obtain softcopy of forms to be used. Search information from CCM website. Call CCM concerning documents needed.

Item 8: Assessment Plan – *The assessment tools for assessing content, process skills (PBL process and technical skills). Reference made to relevant tools provided in the appendix. List of rubrics: presentation, analytical and critical thinking, report writing, peer evaluation/teamwork/group, self evaluation, creative and innovative, life- long learning, entrepreneurship, problem solving, reflection/debriefing. Rubrics can be in the form of likert scale, checklist, criterion, holistic, open ended, etc. Frame in a sentence stating the type of rubrics to be used and rationale behind.*

Assessment Plan

The incorporation documents are assessed based on the descriptors and criteria found in Table 4.

Item 9: Problem Crafters – *Individuals who contribute problem scenarios from various disciplines. They are expert practitioners of PBL who have implemented the scenarios in their teaching and learning.*

PBL Crafters

Zuaini Ishak
Nor Aziah Abd Manaf Masanita Mat Noh Sazali Saad
Dzarfan Abdul Kadir
Mohamad Naimi Mohamad Nor

Table 4: Incorporation Document Assessment

INCORPORATION DOCUMENT ASSESSMENT						
		Least complete and inaccurate		**Most complete and accurate**		
NO.	**ITEM**	**1**	**2**	**3**	**4**	**TOTAL**
NAME SEARCH						
1	Cover letter					
2	Fees					
3	*Form 13A*					
	- content					
	- signature					
	Format					
INCORPORATION DOCUMENT						
1	Cover letter					
2	Form 6					
	- content					
	- signature					
	Format					
3	*Form 48A*					
	- no. of directors					
	- copy of identity card					
	- content					
	-signature					
	- commissioner of oath					
	Format					
4	*Memorandum*					
	Front page					
	Clauses:					
	- name					
	- objects					
	- authorized capital					
	- liability					
	- subscribers' details					
	Stamp duty					
	Format					
5	*Article*					
	- clauses					
	- private co					
	- first director					
	- first company secretary					
	- subscribers' signature					
	Stamp duty					
	Format					
6	Approval letter					
7	Original copy of Form 13A					
8	Fees on Authorized Capital					
AFTER INCORPORATION						
1	Cover letter					
2	*Form 49*					
	- content					
	- signature					

	Format					
3	*Form 24*					
	- content					
	- signatures					
	Format					
4	*Form 44*					
	- content					
	- signature					
	Format					
	TOTAL					
		x 1	x 2	x 3	x 4	Score = ___
Other comments:						

4. Conclusion

PBL is claimed as one of the approaches highly recommended in teaching of business programs whether it is at the undergraduate or postgraduate level. The nature of PBL requires the instructor to be well-versed in issues pertaining to the workplace. Thus, he/she has to be creative and innovative in crafting the scenarios so as to be real and authentic. The scenarios presented will require students to search and read information from various sources and discipline, engage in discussion, integrate information, and make decisions. All these tasks require the students to apply higher thinking skills which are relevant to stimulate them into being an independent learner. As such the scenarios need to be well thought.

In order for instructors to be able to craft or design an effective PBL scenarios, he/she need to understand learners' ability and level of the course to be taught, types of knowledge and its objectives, and types of questions that will trigger learners' to acquire new knowledge so as to be able to handle the scenarios presented.

This paper has presented a clear guideline on what is required when crafting/designing a good PBL scenario in company secretarial practices in the Malaysian context. It has provided the taxonomy on the types of knowledge and problem, a checklist to guide during the crafting process, differentiate between good and bad scenarios and presented a sample of a good scenario in class.

Reference

Barrows, H, S. (1994). *Problem-based Learning. Problem-based learning applied to medical education.* Illinois: Southern Illinois University School of Medicine.

Bransford, J. D., Broen, A. L., & Cocking, R. R. (1999). *How People Learn.* Washington, DC: National Academy Press.

Dolmans, D. H., Snellen-Balendong, H., Wolhagen, I. H., & Van der Vleuten, C. P. (1997). Constructivism and The Technology of Instruction on O'Donnell, A. M. *Constructivism by Design and in Practice: A Review, Issues in Education, 3(2),* 285. Margetson, D. (1987). The question-led design of a degree programme. *Higher Education Research and Development.* 6, 151-173.

Mauffette, Y., Kandlibinder, P., & Soucisse, A. (2004). The Problem in Problem-based Learning is the Problems: But do they motivate students? In M. Savin-Baden & K. Wilkie, *Challenging Research into Problem-based Learning.* Maidenhead, Berks: Open University Press.

Nor Aziah, A.M., Zuaini, I. and Wan Nordin, W.H. (2011). Application of PBL in Financial Accounting Principles Course. *Malaysian Journal of Learning and Instruction* (MJLI), 8, p. 21 – 47.

Savin-Baden, M., & Major, C, H. (2004). *Foundations of Problem-Based Learning,* England: Society for Research into Higher Education and Open University Press.

Schmidt, H. G., & Moust, J. (2000). Towards a taxonomy of problem used in problem-based learning curricula, *Journal on Excellence in College Teaching,*11(2/3): 57-72.

Temasek Polytechnic. (2006). PBL Foundation Programme Learning Academy, Temasek Polytechnic: Singapore. Wee, K. N. (2004). *Jump Start Authentic Problem-Based Learning.* Singapore: Prentice Hall.

Bildungslandschaft or the inter-organizational cooperation network approach (ICNA) as a new approach to attracting pupils to science and technical education

Annette Grunwald * · Lars Bo Henriksen † [a]

[a] *Department of Development and Planning, UNESCO Chair in PBL in Engineering Education - Aalborg University, Vestre Havnepromenade 5, 1. Aalborg 9000, Denmark*

Abstract

The paper presents a short review of the literature on attractiveness and argues for the need to consider an inter-organizational cooperation network (ICNA), which organizes out-of-school learning as a necessary and new perspective to promote attractiveness in technical education. The paper offers a case of cooperation: a Pupils' University, for 5th and 6th grade pupils in primary schools within Northern Jutland, Denmark with a discription of the network and a discussion about how learning structures influensces the learning proces. The paper highlights the contribution of the new concept of a network approach to attractiveness compared to other approaches.

Keywords: case study research, attractiveness, networked learning, inter-organizational learning, inter-disciplinarity, out-of-school learning

1. Introduction

Attractiveness means "the quality of arousing interest" (thefreedictionary.com). There is a major research interest in the interest-concept, which is central in science education (Krapp & Prenzel, 2011, p. 44). Lindahl points out that research on interest in science and technology is very complex and "difficult to get a grip on" (2003, p. 50), and Krapp & Prenzel write that the construction of interest is "a multidimensional construct" with both cognitive and emotional categories "((2011, p. 30, referring to Gardner, 1996; Hidi, Renninger & Krapp, 2004; Schiefele, 2009).

A brief overview below of causes and issues that relevant research has uncovered, will illustrate the complexity of the issue and identify where there is need for further research.

In general Lindahl (2003) summarizes, on the basis of research by Gardner (1975) and Schibecis (1984), three categories of importance to science interest: the **individual students**, **factors in schools** and **factors outside schools**.

For the **individual students** the factors of gender, age and, personality are mentioned as important to science interest.

Factors in schools that influence science interest are manifold. They are, among others the course content, topics covered, pupils influence, pedagogical methods, language interaction in the classroom and the science teacher (Lindahl, 2003). Aikenhead (1996) in his research draws attention to a cultural barrier. Science is perceived as an alien culture to many students. The difference between the context of learning science in school and the context of implementing this knowledge in daily life and student experience is vast. Stocklmeyer, Rennie & Gilbert (2010) point out that "the nature of the curriculum" is a "major reason for the lack of interest". The science curriculum is "looking inwards to the canon of orthodox natural science, that is, at the products and processes of science itself". The traditional formal science education has too many problems of deficient attractiveness, as briefly outlined above. Many efforts have been made to "increase the meaningfulness of student learning" and "change the way in which science is taught" in the formal system (Stocklmayer Rennie & Gilbert, 2010, p. 4). However, their conclusion is: "None of these efforts have so far been effective in initiating sustained change on a wide scale."

As for **factors outside school** Lindahl brings up "home" and "society"(2003, p. 46-48). Learning environments outside of school have likewise received much attention in recent years (see eg Eshach, 2007; Rennie et.al, 2003). The idea is that out-of school learning can solve some of the problems identified earlier in this article, especially the relevance of learning, the nature of the curriculum and the cultural barrier. Besides "home" and "society" out-of-school learning are outreach activities from individual companies (eg Danfoss Universe), museums (Waltner & Wiesner, 2009), zoos (Scott & Matthews, 2011), NGOs or others (Technologiestiftung Berlin, 2009), and educational institutions such as university colleges and universities etc. (Guedens & Reynders, 2011; Grunwald a, b, 2012). Still, Eshach´s point should be highlighted: "It seems as if there is a gap between the feeling that great potential may lie in school field trips, and some of the recent research results indicating that this potential is not fully achieved (2007, p. 175)." Thus, the question is whether greater involvement from institutions outside school can help to provide specifically designed learning opportunities that can help create more meaning, relevance, and authenticity to students than schools alone can? And what will it take in order to make a better use of the potential? The starting point of this article is that while it is important to look at learning outcomes, there seems to be a blind spot caused by not adequately looking at cooperation networks organizing out-of-school learning.

* Corresponding Annette Grunwald. Tel.: +45-99-40-8285, *E-mail address*: grunwald@plan.aau.dk
† Corresponding Lars Bo Henriksen. Tel.: +45-99-40-9817. *E-mail address*: lbh@plan.aau.dk

2. Cooperation between non-formal and formal education

The research on "Bildungslandschaften", which is a relatively new concept (Mack, 2009, p. 62) in the German debate on education, may be able to provide a perspective that can be used here. The concept of Bildungslandschaften seeks to combine in-school and out-of-school education and learning. In the current theoretical discussions regarding German education policy and education, a systematic and broad cooperation between different actors is described in order to address specific identified issues that may lie at the local, regional or even national level. The purpose is to create "experience space" for children to create ideas/conceptions about their personal future (Bollweg & Hahn 2011: 13).

We will emphasize one point from the discussion of “Bildungslandschaften”, which may be useful in the discussion of supporting young people's interest in science and technical education. The point is that education and cultural formation (Bildung) is to be understood in a more wide holistic sense as learning and education landscapes. The term “Bildungslandschaft” includes both education, up-bringing and childcare as a complete educational and support program. For this very reason it is used in this article. Embedded in this holistic perspective is the desire to overcome segmented thinking and acting and discrimination within the educational system, in order to understand the learning process from birth to young adults. This thought process takes its point of departure from the biography of the individual child (Weiss, 2009, p. 31).

3. Problem Formulation

As mentioned previously, there is a gap between the expected potential of non-formal out-of-school learning activities for students and actual increased interest and motivation in science learning.

The assumption in this article is that cooperation between formal and non-formal education can help to exploit the potential of non-formal out-of school learning for primary school pupils.

The problem statement is:

How can a network approach and the knowledge of the players and the players' conditions in the network help to exploit the potential of non-formal out-of school science learning for primary school pupils?

This article will contribute to the discussion on what a network approach can provide compared to other approaches that, despite many efforts, have not been shown to operate satisfactorily with regard to supporting interest in science and technical education. By looking at a specific network- the organizing cooperation network around the Pupils’ University SKUB - and following the development of this network over a four year period, there is a unique opportunity to draw some conclusions on the contribution of an interdisciplinary cooperation network in attracting pupils to science and technical education.

4. The case: a cooperation network at a PUPIL´S UNIVERSITY program on climate and energy for 5th and 6th graders in primary schools

The Pupil's University SKUB on climate and energy at Aalborg University (www.skub.aau.dk) targets fifth and sixth grade primary school students in Northern Jutland, Denmark. The project application and coordination was done by Freie Universität Berlin through the EU project SAUCE-"Schools at University for Climate and Energy" (www.schools-at-university.eu), and supported by the EU program "Intelligent Energy-Europe: For a sustainable future." The Pupil's University SKUB at Aalborg University was initiated by the Energy Planning Group at the Department of Development and Planning. The project aim was, inter alia, (1) to develop cooperation between European universities to establish the pupils’ university on campus as a new teaching method in energy and climate teaching, (2) to increase pupils' understanding of renewable energy and intelligent use of energy as the basis for the sustainable development of society and to make them aware of different options, (3) to support students' interest in green technology and science.

The Pupil’s University SKUB held its first program in 2009 with the participation of 640 students, 400 in 2010 and 710 in 2011. The author of this paper was the manager of this project in the three-year period. After the EU project was finished in 2012, the Center for Teaching in Nature, Technology and Health in Northern Jutland (NTS) at Aalborg University took over the management of the project and completed a program. The research discussed in this paper covers this four - year period from 2009-2012 with the involvement of a total of 108 classes consisting of 2260 students and their teachers.

Each annual program lasted for one week. A school class participated for one day at the university with students enrolled at the university, in the opening event in the auditorium and in two different workshops. This structure was chosen to show the peculiarity of the Aalborg model of teaching in small groups with the opportunity for hands-on work. Examples of workshops are: “When the waves are high” on the use of wave energy in the laboratory; “How can you save electricity?” as well as “Architect for a day” on eco-friendly construction.

The success of the project can be read as follows: The project team has, in collaboration with university teachers, developed workshops that have become increasingly practical and problem oriented and thus more relevant to students. More than 80% of the children would like to come again. The participating teachers gave SKUB an average score of 4.1 on a scale of 1-5 where 5 is the best. Some schools and teachers attended all four years and have made participation in the program an integral component of the school year science education.

5. Research method

The research method is anchored in a case study method. It is an action research / participatory research where the researcher was the project manager for the first three years of its start-up and development. Data material includes summaries, observations, semi-structured interviews with steering committee members, mail correspondence and evaluations in the form of questionnaires to students, school teachers and university lecturers done after each of the four completed programs from 2009-2012.

The theoretical framework for the analysis is based on the relationship between actors, their learning processes and learning structures that are addressed from a theoretical perspective of "organizing learning systems", or so-called "learning networks" in work-based learning (Van der Krogt, 1995, 1998, Poell et.al., 2000). From this theoretical perspective the three dimensions of "learning networks" meet in a kind of cycle, where learning structures influence actors, that then implement learning processes, which in turn affect learning structure, etc.

Learning structures are defined here as content and organizational structures, and expanded in this project to include resource structures as well (See Table 2). Learning structures are the framework for, and thereby the context for, the learning of the inter-organizational cooperation network. The analysis is carried out and discussed in the following section.

6. Analysis and discussion

A. *A brief description of the cooperation network*

"To start something totally new ... I think it has been a very exciting process" (Member 5, Table 1). As this statement shows, the project had to develop a new partnership between Aalborg University and Danish primary schools that did not exist in this form before. Therefore, it was necessary to involve partners with knowledge of primary schools right from the start. That was the reason for the establishment of the steering committee, which *"... was one of the best ways to gain some knowledge regarding elementary school conditions into our planning because none of us had sufficient knowledge regarding daily life in public schools"* (Member 3, Table 1). The overall composition of the steering committee was agreed upon in the internal project group at Aalborg University just after the establishment of the project (see Table 1).

It is important to mention that the other participants in the European SAUCE project had not established this type of steering committee. The reason behind the need for a steering committee was that we in the Aalborg project had decided to develop a training program mainly undertaken by university teachers. The other European partners in the project involved environmental educators from outside the university to a much higher degree. These educators had experience in teaching children and were, because of the incentive structure at the university, easier to recruit than university lecturers. Table 1 shows the individual members of the steering group, their organizational association and their diverse professional backgrounds.

Steering committee member	**Place of employment**	**Education and work experience**
1	AAU	Energy expert, researcher, multidisciplinary experience in technology and social sciences, educational background in economics and anthropology
2	AAU[‡]	German engineering background; long experience in private enterprise, environmental NGO, and as a school teacher; supplementary education as an environmental adviser, holds a master's degree in learning processes
3	AAU[§]	Physicist, former teacher and college lecturer in physics, project participant at the University, background in the folk high school world
4	AAU§	Background in IT at teacher college and knowledgeable in the folk high school world
5	A Primary School in Municipality X	Teacher of mathematics, nature and technology, carpentry, and music
6	B Primary School in Municipality X[**]	Teacher of physics, mathematics, and nature and technology

[‡] Employed part-time by the project (around half-time).
[§] Employed hourly as needed for the tasks of the project.
[**] Participated from Autumn 2008 to Summer 2010.

7	C Private Primary School in Municipality X	Teacher of social studies, biology and geography, and nature and technology in the project period
8	School administration in Municipality X	School consultant, educated schoolteacher, holds a master's degree in didactics of natural science, head of the "natural" school in the municipality
9	Municipality Y, the job market department and D Primary School in Municipality Y ††	Teacher, experience in human relations, now supervises education for young people (75%-time) and establishes school learning for the Primary and Secondary School D (25%-time)

Table 1. Composition of the steering committee for the project Pupil's University, SKUB, Oct. 2008-Aug. 2011.

As Table 1 shows, the members of the steering group have very diverse backgrounds. As a member of the steering committee expresses it, it was *"... the diversity that gave decent results ..."* (Member 3). It is particularly noteworthy that the teachers have very different educational and professional backgrounds, reflecting the composition of a normal Danish primary school.

During the project period it emerged very quickly that there was a greater need for networking. It was necessary to establish contacts and cooperation within Aalborg University both to identify committed teachers and to get connect with different levels of management to get the project embedded in the organization. Local and regional networking was also needed to include schools and school administrators (Grunwald, 2012, p. 115). This article focuses only on the learning process of the steering committee, as described in Table 1. For this reason, the evaluation results from university teachers, primary school teachers, and pupils are not included in the analysis here, as more in-depth discussion of these other actors would be necessary.

B. Framework conditions as the context for a network learning process

To answer the question of how ICNA can help to promote the attractiveness of science education, it is necessary to know something about the framework conditions of the different actors in the network and how these influence the network learning process. Partly inspired by Poell et al.'s theoretical perspective of "organizing learning systems" in work-based learning, we have modified and further developed this perspective in order to include a concrete inter-organizational context. Brief descriptions of three learning structures that have decisive influences on learning in the steering group (the arranging network) are given in Table 2. They include content, organizational, and resource learning structures. In this article we focus on the importance of the content structure.

Learning structure	**Explanation**
Content structure	The content learning structure and framework from the members of the steering committee. This is what has to be learned by the members to implement the project and meet the project objectives. "What is learned … may take the form of knowledge, expertise, skills, understanding, insight, opinion, attitudes" (Illeris, 2007, p. 37).
Organizational structure	Division of tasks, responsibilities, roles "in organizing the learning activities" (Poell et al., p. 34). Organizational learning structure from players that can influence the learning in the steering group and the organizational structures inherent in the whole project.
Resource structure	Not a part of Poell et al.'s perspective. Based on the evaluation of the analysis material, it is especially temporal and economic factors that affect the learning process in the steering committee.

Table 2: Learning structures

The steering committee met ten times, each time for three hours. The meeting structure was determined by the internal AAU group's proposal for the agenda. These could be ideas, suggestions, or problems that the AAU group found important to confront with the other members of the steering group in order to hear their opinions and suggestions. The non-AAU external members of the steering committee supplemented with their knowledge, evaluations and proposals. The subjects discussed included development of program structure, the pedagogical design of the workshops, further development of the teacher group, how to co-finance the project, evaluation of the program, how it could be continued, etc.

1. Different worlds are brought into contact

"One could, for a moment, think that university and secondary schools and primary schools, each have something to do with teaching and something with learning ... so they are quite similar to one another. They do perhaps up to a point but there are, well, also many ... different worlds ..." (Member 9).

†† Participated from Summer 2010 to Summer 2011.

Another member of the group, referring to the learning process through the project, explains how to understand the "different worlds" as follows:

"It was ... a challenging process. Because I could feel when I walked away that I had very much been focused on trying just to get the dialogue launched in any way possible... from the angles you yourself saw it from" (Member 8).

How can the different worlds that were brought into contact and the different "angles" each member brought to the process be described?

An indication of these different perspectives is given in the Table 1 overview of the professional backgrounds of the members. A closer look at the individual members reveals that the public school teachers are especially focused upon meeting the requirements in the law set out in the Ministry of Education's so-called "common goals" , containing aims and content descriptions for each curriculum and grade in the Danish school (Members 5 and 6). This means that it is a must for out-of-school activities to be in accordance with these common goals.

In addition to this, the municipality has a *"... school policy that is agreed upon by politicians for all schools in Aalborg ... with focus areas as important goals for the teaching activities* ..." (Member 8). Schooling is to a high degree politically determined and a changing area where, for example, *"...the political system at the national level sometimes overrules and sometimes adds teaching tasks that should be implemented in addition to the declared focus areas of the municipality"* (Member 8).

The municipality school consultant here serves to connect the administration, primary and secondary schools, politicians in the municipality, and the public. *"I have 12 part-time lecturers who teach at various historical and science out-of-school workshops at different locations in the municipality and receive pupils every day throughout the school year. This work I am trying to implement in the strategy of administration and municipality management"* (add attribution). In the work of the consultant it is also important *"to be aware of what is going on with regard to the political level and the development in education, and try to transfer this information to schools ... in dialogue"* (Member 8).

The education supervisor is a part of the steering group through his 25% employment at a school that focuses on establishing, developing, and maintaining out-of-school learning for pupils of the school in companies, secondary education, and the wider community. In this context, the school was interested in establishing cooperation with Aalborg University *"because for several years we actually have talked about ... if we could be able to get an ... open door into the university ..."* (Member 9).

For the four University-affiliated members see Table 1. The first priority was to implement the project in a satisfactory manner. (See the purpose of the project in the case description.).

2. How to integrate school and university pedagogically

As described above, the primary school teachers need to fulfill the common goal of science education. Therefore a large part of the discussions during the meetings were about *"... bridging the gap between the teaching pupils will participate in [at the university] with what is actually happening in the schools. This is probably the biggest problem"* (Member 8).

"I was well aware that at the university the lecturers would not have the knowledge regarding the challenges the schools are facing and the framework in which the teaching is embedded, or what you must achieve in school, the educational goal you have and how you find the best way to coordinate it with what scientists are at present researching in and have interest in. This is really, really difficult, but I think it's good that it was articulated ... It is very difficult. But I also feel that teachers from the university environment were willing to listening to the challenges" (Member 8).

During the meetings there was much talk about the proposed solution of developing teaching materials to be used in schools in preparation for the Pupil's University. The first ideas for teaching materials were discussed in with the whole group. This development work stopped, however, because there were no resources in the EU project for this work, and because the project failed to find additional financing.

The meetings were filled with discussions of the pedagogical design of the workshops at the University. One of the points made is that students should have the opportunity to explore and experiment by themselves. One member concludes, *"... much of the teaching carried out at Aalborg University is also much of what we recommend in science didactics ... that really ought to be formed in such a way that it plays together"* (Member 8).

This refers to problem-based learning that is student-centered and in which a "problem is the starting point directing the students' learning process and places the learning in a context" (Barge, 2010). There is still a long way to go toward achieving this goal, as this research project shows. To make it "play together," i.e., to develop problem-based learning in collaboration between school and university, where students may themselves identify problems they are interested in working on, would require a considerable amount of inter-organizational cooperation between school and university.

Another, perhaps competing, goal comes from the primary school teachers, who wish to show their students something *"great"*. By "great," Member 7 means that *"... the university has some things that you do not see in school"*. Another teacher expresses this need in a different way: *"We want to see something gear"* (Member 5). "Gear" could refer, for example, to the university's ocean wave laboratory. It is clear from the empirical evidence that this statement should also be seen in light of lack of resources for equipment in schools (Grunwald a, 2012).

It is clear that it would have been possible to make a program at the University without putting together a steering committee. It might also have been possible to gain permission to attend some classes (although the cooperation network with schoolteachers was a great help at the beginning of the project). But if the goal is to get beyond the stage called "soft drink visits" or just a fascinating "excursion" then collaboration among the different actors is necessary. In the case of the Pupil's University, the experience of sharing and knowledge building through learning about each other's daily lives, frame conditions, professionalism, and work environments have been of great value: *"I think the cooperation with the teachers was invaluable! And it saved us from many pitfalls"* (Member 4).

C. A brief remark regarding resource structures

The meetings were organized in such a way that there was time for discussions. This was possible because the schoolteachers' participation and work hours were funded by the EU project.

The importance of time as a resource in establishing and developing a new type of cooperation is evident from the following statements:

"In such a steering committee, it is important that there is some time ... If we had met several times but with less time per meeting, I think it would have been hopeless ... Exactly because it [the project] started up from zero and had to be developed from the bottom, it became of course necessary to talk a lot and develop many ideas."
"When you look at how much comes out of it ... Obviously, if you spent the same time discussing things when making a course as a teacher, then you would have to work 80 hours a week. If it took you so long to find solutions.... even so, I do not see it as a problem (in this project). It is probably necessary" (Member 7).

This statement is in accordance with the general opinion in the group that it was necessary to invest time in learning to understand each other's working conditions (final evaluation of the steering committee, August 2011). Only on this basis is it possible to build a real bridge between primary school education and out-of-school education.

7. Conclusions

Out-of-school teaching in itself does not necessarily result in more pupils becoming interested in natural science and technical fields. This article and the underlying research indicate that it is necessary to focus on the organizations that organize out-of-school teaching and their learning processes. A better bridge between formal (primary schools) and informal (in this case, Aalborg University) learning is necessary if the out-of-school activities are to give the pupils more than a single, disconnected experience. Without this bridge, the organizing institution is more or less "fumbling in the dark" in developing educational offerings based solely on its own understanding and assumptions. Unfortunately this disconnect happens in many cases because there is a lack of research on the organization of the learning process in a cooperation network. As our literature study on attractiveness and science interest shows, the focus is largely directed at out-of-school learning outcomes, i.e., what the students got out of the class. In this study of a cooperation network in a concrete case, the Pupil's University SKUB at Aalborg University was followed throughout the project process, providing a unique opportunity to study the learning process in such an organizational network, which was strongly influenced by the conditions of the involved organizations.

The European project SAUCE gave the economic opportunity to gather an inter-organizational network and to spend the time needed to understand each other's working conditions, such as regulatory requirements, incentives, work environments, and pupils' technical qualifications. Though it required a major time investment, the cooperation network led to successful collaboration with interesting educational programs for fifth and sixth grade pupils. In addition to the steering committee, a large network of teachers, school consultants, and University employees was established. With the conclusion of the EU project, this continuity was broken. It is possible to ensure the continuation of the Pupil's University at Aalborg University according to the established format, but the experiences and knowledge that have been built up through the cooperation of the steering group and larger cooperation network during the course of the three-year project cannot be further developed. The steering committee no longer exists. This creates difficulties for the new project manager; in fact, the project manager has already changed twice since the end of the SAUCE project. In this way, much valuable experience has been lost. This development reflects some basic conditions regarding the project-borne learning landscape.

Preventing such loss of knowledge, experience, insight into other partner's working conditions, and pedagogical considerations requires a more continuous and formalized type of cooperation between the involved organizations. One proposed solution is an inter-organizational cooperation network approach in the form of a “Bildungslandschaft.”

As the findings in this research show, the primary school teachers and the school consultant consider the biggest problem to be that there is not a close enough connection between school education and the program at the University. The steering committee has made considerable efforts to create a better link between science education in school and pupils’ experiences at the University. As discussed in this article, it is especially due to lack of allocation of the needed resources in this case. It should also be mentioned that the Pupil’s University project at Aalborg University went beyond the efforts of project partners in the other EU countries in establishing this systematic collaboration between the university and the primary schools.

This article shows that it is necessary to focus on the framework conditions of the organizations involved and also to look at the framework conditions that a concrete collaborative project (here the SAUCE project) creates for the learning process and how these shape out-of-school learning for pupils. Other approaches, such as looking at science didactics, teachers’ professional backgrounds, or pupils’ motivation give the inter-organizational network a more holistic view of both the learning process in the network and the conditions of the learning process. Knowledge of pupils’ science abilities and interests are represented through primary school teachers and the municipality school consultant. Continuing this way of thinking and involving students in a cooperation network of this kind will further enhance the collaborative development of a motivating out-of-school science learning process.

If we take the recommendations for science didactics seriously by instituting a problem-based approach in which students study problems or, ideally, work on self-defined problems, it will require closer cooperation between schools and the university. It will require much more cooperation, coordination, and mutual understanding of each other’s work and framework conditions. It will also require that the “Bildungslandschaft” approach establish a binding collaboration with sufficient allocation of resources and a comprehensive educational approach that increases the attractiveness of technical programs by means of building a bridge between primary and secondary schools and technical/engineering education.

ICNA is considered to be an indispensable way to support the interest in and attractiveness of technical programs. There is a further need for research into how cooperation between formal and non-formal education in the form of a holistic “Bildungslandschaft” approach can be facilitated and organized.

References

Aikenhead, G.S. (1996). *Science education: Border crossing into the subculture of science.* Studies in Science Education, 27, 1–52.

Barge, S. (2010). *Principles of Problem and Project Based Learning - The Aalborg PBL Model.* Harvard University, Prepared for Aalborg University.

Bollweg & Hahn. (2011) *Bildungslandschaft: Zur subjektorientierten Nutzung und topologischen Ausgestaltung.* In: Räume flexibler Bildung. Bildungslandschaft in der Diskussion. Bollweg P, Otto H-U (Eds); Wiesbaden: VS Verlag für Sozialwissenschaften: 13 - 35.

Danfoss univers. http://www.danfossuniverse.com/, 24.01.2013

Eshach, H. (2007). *Bridging In-school and Out-of-school Learning: Formal, Non-Formal, and Informal Education.* Journal of Science Education and Technology, Vol. 16, No. 2.

Guedens & Reynders (2011). *Science Outreach Programs as a Powerful Tool for Science Promotion: An Example from Flanders.* ACS Publications. J. Chem. Educ. 2012, 89, 602-604.

Grunwald, A. (2012a). *Elevuniversitet om energi og klima – et samarbejde i netværk: Nye perspektiver for naturfagsinteressen?* NorDiNa, Vol. 8, Nr. 2/12, 09.2012, s. 108-121.

Grunwald, A. (2012b). *Broschure over resultater af Elevuniversitetet SKUB, 2009-2011.*

Illeris, K. (2007). *Læring.* Roskilde Universitetsforlag. 2. rev. Udgave, 2. oplæg.

Krapp & Prenzel. (2011). *Research on Interest in Science: Theories, methods, and findings.* International Journal of Science Education, Vol. 33, No. 1, 1 January 2011, pp. 27-50.

Lindahl, B. (2003). *Pupils’ responses to school science and technology? A longitudinal study of pathways to upper secondary school.* Ph.d. afhandling. Göteborg, Sweden ISBN 91-7346-467-8

Mack, W. (2008). *Bildungslandschaften.* I: Coelen &Otto: Grundbegriffe Ganztagsbildung – Das Handbuch. VS Verlag für Sozialwissenschaften.

Paris, Yambor & Packard. (1998). *Hands-On-Biology: A Museum-School-University Partnership for Enhancing Students´Interest and Learning in Science.* The Elementary School Journal. Vol. 98. No 3 (Jan. 1998), pp. 267-288.

Poell, R.F., et.al. (2000). *Learning-network Theory. Organizing the Dynamic Relationsships between Learning and Work.* In Management Learning. Sage Publications.

Projekt samspil uddannelse og erhverv. Project between primary and secondary schools, VIA University College Horsens, firms and members of municipalities. Projektmanagement VIA University Horsens, (projektsamspil.dk)

Rennie, L. et.al.(2003). *Towards an Agenda for Advancing Research on Science Learning in Out-of-School Settings.* Journal of Research in Science Teaching, Vol. 40, No. 2.. pp. 112-120.

Richardt, C. (2008). *Was bewirken Kinderuniversitäten? Ziele, Erwartungen und Effekte am Beispiel der Kinderuni Braunschweig-Wolfsburg.* Publikationen zur Hochschul_PR, Band 3.

SAUCE, Schools at University on Climate and Energy, http://www.schools-at-university.eu/

Sänger, F. (2003). *Die Kinderuniversität.* Martin-Luther-Universität Halle / Wittenberg. Vordiplomarbeit.

SchuleWirtschaft. http://www.schulewirtschaft.de/www/schulewirtschaft.nsf/ID/EN_Home. Cooperation between Business and primary and secondary schools.

Scott & Matthews. (2011). *The "Science" behind a Successfuld Field Trip to the Zoo.* Science Activities. 48:29-38, 2011.

Steno Museet: (www.stenomuseet.dk/skoletj/) 23.01.2013

Stocklmeyer, Rennie & Gilbert. (2010). *The roles of the formal and informal sectors in the provision of effective science education.* Studies in Science Education. Vol. 46, No. 1, March 2010, 1-44.

Technologiestiftung Berlin (2009). *Berlin-Brandenburg: Hier forscht die Jugend! Schülerlabore und weitere ausserschulische Lernorte für die MINT-Fächer.*

Quistgaard, N. (2006). *Oplevelsen og udbyttet af skolebesøg på teknik- og naturvidenskabscenter.* MONA 2006-1.

Weiss, W. (2011). *Kommunale Bildungslandschaften – Chancen, Risiken und Perspektiven.* JuventaVerlag Weinheim und München.

Waltner & Wiesner. (2009). *Learning effectiveness of museum visits as part of physics class.* Zeitschrift für Didaktik der Naturwissenschaften, Jg. 15. 2009.

Transforming Engineering Education for Innovation and Development - A Policy Perspective

Dr Tony Marjoram
Guest Professor, Aalborg University
Former Head of Engineering, Department of Basic and Engineering Sciences, UNESCO

Abstract

Engineering and technology are of vital importance in innovation, social and economic development in higher and lower income countries. Development is driven by engineering applications and infrastructure, and most innovations derive from engineering. The last 50 years has seen significant change in knowledge production, dissemination and application, and associated needs for engineering, and yet engineering education has changed little over this period. This paper discusses the important role of problem-based learning and humanitarian engineering in promoting the interest, enrolment and retention of young people in engineering, and the need to develop policy perspectives on the transformation of engineering education.

*Keywords:*Engineering, education, transformation, innovation, development

1. Introduction

Engineering is of central importance and drives development around the world – our physical infrastructure is designed, built and maintained by engineers. Engineers apply knowledge and create technology - most innovations derive from engineering (Metcalfe, 2009). In terms of technological, social, economic and cultural change, engineering is the most radical profession. On the other hand, engineering is also most conservative - engineering education has itself changed very little over the last 50 years. This is one factor in the decline of interest, enrolment and retention of young people in engineering and reported shortages of engineers in many countries. These are major challenges for eng[1]ineering. This is at the time of another major global challenge for engineering - in facilitating a "greener", sustainable use of resources, in mitigating the effects of and adapting to climate change, and in humanitarian engineering and development, especially poverty reduction.

This paper looks at the importance of project- and problem-based learning (PBL) in engineering education in the context of change in knowledge and technology production, dissemination and application, and the major issues and challenges facing the world, especially poverty reduction and sustainable development, climate change mitigation and adaptation. The importance of humanitarian engineering and technology in project and problem-based learning is emphasised, along with the need for engineering to be seen as a major component in addressing global issues and challenges and opportunities, for engineering to be seen as 'cool', and for the development of engineering studies, policy and planning.

PBL is a vital innovation in the transformation of engineering education, and is complemented by the development and humanitarian engineering. With a focus on relevance and need, PBL and humanitarian engineering is crucial in the promotion of interest, enrolment, employability, mobility and the retention of students and engineers around the world, and will help to reduce the brain drain of engineers from developing countries.

2. Changes in knowledge production, application and dissemination

There have been significant changes in knowledge and technology production, dissemination and application over the last 50 years, particularly from what has been typified as "Mode 1" (academic/disciplinary) toward "Mode 2" (problem-based/interdisciplinary) (Gibbons et al 1994 and 2001; Etzkowitz and Leydesdorff, 2000). This has reflected changes in science and engineering, moving from theory toward practice, individual to teamwork, with converging bodies of knowledge, and converging professional practice and employment. Knowledge and technology production, dissemination and application also reflect waves of technological change and innovation – from the slow pace of change from hunter-gatherer to agrarian societies, to the faster pace of change beginning with the "Industrial Revolution". The first major wave of technological change in the early 1800s was based on iron and water power, the second wave in the later 1800s was based on steam, the third in the early 1900s was based on steel, the fourth in the later 1900s on oil, and the fifth, at the turn of the century, on ICTs. Each of these waves was in turn reflected in modes of education and training – from craft mentor-based hands-on approach, to apprenticeships and trade-based through to the development of technical schools, colleges and universities, with an increasing science, theory and hands-off approach. Until the 21st Century, with "post-industrial science" and the convergence of science and engineering based on interdisciplinarity, networking and a problem-solving, systems approach, with an increasing focus on applications. At the start of the 21st Century, there was increasing interest in a sixth wave of innovation based on new modes of knowledge production,

[1]Corresponding Author: Dr Tony Marjoram, Tel.: +61 437 405 412
E-mail address: t_marjoram@yahoo.com

dissemination and application. Interest is also developing in the seventh wave, based on clean technology for climate change mitigation and adaptation.

The history of the world is the history of innovation, and waves of innovation – the Stone Age was not displaced by the Iron Age because they ran out of stones (Yamani, 1973). Innovation relates to the introduction, dissemination and use of an idea, method, product or process that is new to the user or user group, although it may not therefore be absolutely new. Innovation initially referred particularly to technological innovation, although the meaning has expanded to include broader subjects – such as innovation in education. Technological innovation was first portrayed as a linear model, where basic science was supposed to lead to applied science, engineering, technology, innovation and the dissemination of technology. The linear model of innovation, from Vannevar Bush, proved to be deceptively simple and endearing, especially for the science community and policy makers in the post-war period, but was later shown to be inaccurate and misleading, although its simplicity has proved enduring. Policy analysis has since moved toward systems thinking, "national systems of innovation" and related regional and global models (Freeman, 1995; Lundvall, 1992), and also to the "ecosystem" model of science, engineering, technology and innovation. While these are more accurate for economically developed, OECD countries (where they were developed, with particular reference to Japan), they can also be misleading in the developing, non-OECD country context, where elements of the innovation system (industry, research, government) are less developed.

Educational practices slowly changed and evolved to match cognitive and professional paradigms, requirements and expectations. The dominant educational paradigm in engineering is that of "engineering science" and the Humboldt model – following the University of Berlin established by Wilhelm von Humboldt, based on a combination of theory and practice. Over time, emphasis on the practical gave way, largely on professional grounds and the desire to emulate science, to increasing focus on theory. This has had a negative impact on the interest and enrolment of young people in engineering, and consequent need for educational approaches for the next generation of engineers based on problem-based learning, projects and real-world needs.

Changes in knowledge and technology production, dissemination and application have also occasioned the need for change in associated learning approaches - toward cognitive, knowledge- and problem-based learning, and the need for innovation and development in engineering education. Engineering is a problem-based profession, and needs a problem-based, just-in-time approach to learning and continued professional development (UNESCO, 2010). The needs for the next generation of engineers are reflected in the Washington Accord graduate attributes and professional competencies (Washington Accord):

1. Engineering knowledge
2. Problem analysis
3. Design/development of solutions
4. Investigation
5. Modern tool usage
6. The engineer and society
7. Environment & society
8. Ethics
9. Individual & team member
10. Communications
11. Project management & finance
12. Life-long learning

3. Issues and challenges facing the world

One of the major overall issues and challenges facing the world is poverty. Poverty is often thought of economically, but relates primarily to the limited access of poor people to the knowledge and resources with which to address their basic human needs and promote economic, social and human development. Areas of basic human need include water supply, sanitation, housing, energy, food production and processing, transportation, communication, income generation and employment creation. Addressing basic needs in these areas consists essentially of the transfer, innovation and application of engineering and technology appropriate to the social, economic, educational and knowledge situations in which poor people live. Such engineering and technology has to be affordable, understandable and build upon local knowledge, skills and materials. This requires an understanding of the needs and knowledge systems of people living in poverty and their participation in the identification, development, adaptation, transfer and application of engineering and technology.

This also requires the provision of information, learning and teaching material using multimedia approaches and ICTs for human and institutional capacity building, and associated support services, particularly micro-finance, to promote technological innovation and application. Technology can then empower the poor by helping them to address their basic needs to reduce poverty – this is also a human right and this approach should therefore be central to a rights-based approach to poverty eradication. Specific regional and social dimensions of poverty and poverty eradication require reference to particular areas and issues – including urban and rural poverty, the problems of young people, the elderly, women and gender issues and the 'feminisation' of poverty. The poverty divide is therefore closely connected to the knowledge and technology divide, and the world can be seen to be divided into technology innovators, technology adopters, and the technologically excluded (Sachs, 2000). The number of scientific research papers and patents per capita population, for example, is in absolute reverse correlation to measures of poverty. It is the responsibility of engineering and engineering educators to address and reduce the knowledge and technology divides.

Issues and challenges facing the real world are listed below, in terms of the percentage of the world population that do not have access to the areas of basic need noted above. Engineering education, in developing and developed countries, is essential to produce the engineers to address these challenges. Addressing basic needs is an engineering issue, with engineering solutions, and project- and problem-based learning is vital to address such real and relevant world issues and challenges.

39% world population do not have safe water – 2.6 billion people
35% do not have improved sanitation - 2.3 billion people
24% do not have electricity – 1.6 billion people
20% live in poverty (<1$/day, 70% women) – 1.3 billion people
15% lack adequate housing/live in slums – over 1.0 billion people
15% lack any ICT connection – over 1.0 billion people
13% go hungry every day - 852 million people

Life expectancy - poor countries: 52 years; rich countries: 78 years.

The most well known international development goals are the 2000-15 UN Millennium Development Goals (MDGs). These consist of 8 MDGs, with 18 quantifiable targets measured by 48 indicators:

1. Eradication of extreme poverty and hunger
2. Achievement of universal primary education
3. Promotion of gender equality and empower women
4. Reduction of child mortality
5. Improvement of maternal health
6. Combating HIV/AIDS, malaria and other diseases
7. Ensuring environmental sustainability
8. Development of global partnership for development

As is common with such goals, they are aspirational rather than actual, and in reality have achieved limited success – although this was at the time of the Global Financial Crisis (only three of the eighteen quantifiable targets have been achieved). As is also common with such goals, there was little mention of how they might be achieved, or what areas of knowledge might be important or instrumental in achieving them. The role of science and technology was only mentioned in relation to MDG8, target 18 relating to ICTs (the very last target), for example, and there was no mention of engineering.

Limited success in achieving international development goals may therefore be of little surprise, given not only the scope of the challenge, but also reflects on the importance of and limited emphasis on engineering and technology in international and humanitarian development, and the generally outdated understanding of the role of engineering and technology in development by the “aid” community and associated policy makers and decision takers.

4. Development and humanitarian engineering and technology

Engineering applications, technology and innovation for development include all levels of technology, from high to low. The crucial consideration is that technology should be appropriate to social, economic, environmental, engineering and technological context. Technology should reflect social need, affordability, operability, maintainability, sustainability, from high-tec solar PV systems, to more common medium and lower tec, for example a foot-operated water pump for African farmers (an innovation as it is a technology new to the user and user-group). For a background on appropriate technology see “Small is Beautiful” (EF Schumacher, 1973). Other areas of development and humanitarian engineering and technology include biogas, water tanks, improved toilets, improved cooking stoves (fuel efficient, smokeless), biofuels (biodiesel, ethanol), biomass gasifiers and building materials.

Interest in engineering and technology for development has waxed and waned over the last 50 years, with increasing interest in appropriate technology in the 1960/70’s. This declined in the 1980s/1990s with changing politics, cuts in aid in many Western countries and linkage to policies of structural adjustment. There was a reemergence of interest in appropriate technology in the 2000s, for example with the appearance of “Small is Working” (UNESCO, ITDG, TVE, 2004), and Appropedia (2006) and the development of Engineers Without Borders groups around the world. So it could not be said that appropriate technology was dead (Paul Polak, 2010), but had been resting. Appropriateness is also a feature of the increasing interest in new modes of knowledge generation and dissemination, networking (sixth wave of innovation), sustainability, greener engineering and cleaner technology for climate change mitigation and adaptation (seventh wave). Engineering and engineering education is of vital importance in contributing to the sixth and seventh waves of innovation, and the development of greener-cleaner engineering and technology will be essential for the survival of humanity and the blue planet.

This includes developed and developing countries – where much of the technological, economic and social change is taking place. This relates to a “political economy of engineering and development” – in developed and developing countries engineering applications and technology depend on knowledge, resources and funding, and in less developed countries this also relates to development assistance and aid. The application of engineering and technology in the development context depends on various considerations, internal and external to engineering:

Considerations external to engineering:

- awareness of the role of engineering/technology in development
- appropriate policy and implementation by policy-makers and decision-takers

Considerations internal to engineering:

- information and advocacy of engineering in development
- inclusion of development issues in engineering education

There are various factors for success in the application of engineering and technology for development, these include the need for:

- Information, advocacy, resources, leadership
- Appropriate policy, need for commitment, implementation of policy
- Technologies to be appropriate to local social and economic needs conditions
- affordable, operable, maintainable, sustainable
- Engagement and involvement of local community and engineers
- Drive by the engineering and technology community, popular champions

Focus on various communities:

- engineering organisations and education institutions
- policy, planning, development in government and private sectors
- NGOs, international and intergovernmental organizations

5. Issues, challenges and opportunities – cool engineering?

As discussed above and reported elsewhere (UNESCO Report, 2010), particular issues and challenges for engineering include:

- Decline of interest and enrolment of young people in engineering (due to negative perceptions of engineering and engineering education)
- Shortage of engineers, technologists and technicians (reported by many countries)
- Brain-drain of engineers from developing countries and serious impact on capacity and development
- Need for investment in infrastructure, capacity, R&D (Obama, 2008, 2013) (following Global Financial Crisis, 2007-8)
- Climate change, mitigation and adaptation, move to lower-carbon future

The decline of interest and enrolment of young people (especially women) in engineering appears to be mainly due to negative perceptions that engineering is uninteresting, 'nerdy', 'geeky' and boring, that university courses are difficult and hard work, that engineering jobs are not well paid, and that engineering has negative environmental impact. There is evidence that young people turn away from science at age 10-12, that good science education at primary/secondary level is vital, and that teachers can turn young people on and off science and engineering (National Science and Technology Centre, Australia, 2007). The image of the nerdy engineer is epitomised in the "Dilbert" cartoon strip, and by Mr Bean (although Rowan Atkinson has a degree in engineering). The overall message in this context is that engineering is uncool!

To address this situation there is a need to counter specific negative perceptions of engineering as boring and uninteresting, and a need to promote public awareness and understanding of the important role of engineering in development. To counter the perception that engineering education and university courses are hard work there is a need to make education and university courses more interesting and relevant for problem-solving, that emphasise a problem-based learning (PBL) approach. To counter the perception that engineering jobs are not well paid there is a need to promote pay parity and the perception of pay parity with similar professions and levels of qualification (although, following the law of supply and demand, it is already apparent that salaries have increased in areas of shortage). Finally, to counter the perception that engineering has a negative environmental impact, there is a need to promote engineering as a part of the solution to sustainable development, climate change reduction and mitigation, rather than part of the problem.

Overall, there is a continued need to address and present an overall picture of engineering to:

- Emphasise engineering as the driver of social/economic development to get engineering on the development agenda
- Develop public and policy awareness of engineering
- Develop information on engineering highlighting the need for better statistics and indicators on engineering
- Promote change in engineering education, curricula and teaching to emphasise relevance and problem-solving
- More effectively apply engineering to global issues such as poverty reduction, sustainability and climate change
- Develop greener/sustainable engineering and technology - the next wave of innovation

It is also useful to note some perceptions of recent trends in academia relating to declining standards, funding, overloaded academics. These have been linked to increasing bureaucracy, corporatisation, public relations and increasing focus on revenue, efficiency, profile and position, based on indices of academic ranking (Hill, Richard, 2012).

6. Positive linkages and opportunities – cool engineering!

Fortunately, many of the above issues, challenges and opportunities facing engineering are linked in the provision of positive solutions. When young people, the public and policy-makers see that engineering is a major part of the solution to global issues, for example, their attention and interest is raised and young people are attracted to engineering. They are also attracted by relevant and innovative pedagogical approaches, such as problem-based learning, and to relevant and appropriate technologies to address global issues, such a sustainability and poverty reduction. To achieve this, there is a need to promote transformation and innovation in engineering education, to include theory and practice that was a core of the original Humboldtian model – to promote fun and fundamentals. It is also important to provide examples of engineering relevance and appropriate technologies for development.

The promotion of relevance in the context of engineering problem-solving to address global issues such as poverty, sustainability and climate change, is exemplified in such initiatives as the Daimler-UNESCO Mondialogo Engineering Award that ran from 2003-2010, attracting 10,000 student participants from 100 countries (Mondialogo, 2010). The Mondialogo Engineering Award was a problem-based, project design exercise involving international student cooperation focused on global issues around a diversity of technologies, including water supply and sanitation, cooking stoves and prosthetic feet. The interest in such issues is also reflected in the rapid growth of Engineers Without Borders (EWB) groups at universities around the world over the last 20 years – which have been shown to attract students, and which several universities have supported in the enrolment and retention of students. Such activities promote engineering and appropriate technology as highly relevant in addressing global issues, ensuring positive feedback, promoting public interest and understanding and conveying the important overall message that engineering is cool!

7. Transformation and innovation in engineering education

To address the issues and challenges noted above, the main goals of transformation and innovation in engineering education are to respond to rapid change in knowledge production, dissemination and application, moving from the traditional, formulaic, engineering curricula and pedagogy toward a cognitive, knowledge-based approach, emphasising experience, problem-solving and insight, with a more just-in-time, hands-on approach, as exemplified by project and problem-based learning. This is also in response to the changing need for engineers to be better attuned to knowledge change in terms of synthesis, awareness, ethics, social responsibility, experience, practice, applications and intercultural sensitivity. Because of rapid change in knowledge production and application, engineers have an increasing need to learn how to learn, in terms of lifelong and distance learning, continued professional development, adaptability, flexibility, interdisciplinarity and multiple career paths. There is also the need for relevance regarding pressing global issues and challenges – including poverty reduction, sustainability (environmental, social, economic and cultural), climate change mitigation and adaptation. These graduate attributes and professional competencies are reflected in the Washington Accord.

Engineers are problem-solvers and innovators, and need to innovate in engineering education toward a curricula focused on project and problem-based learning, with particular reference to real world, relevant issues and problems, cleaner and greener engineering and technology appropriate to social, economic, environmental and cultural context. Curricula should reflect formal and informal learning trends, especially the use of ICT resources for student-centred learning, with limited lectures and staff acting more in a role of learning facilitators. There should be a focus on development and the assessment of graduate attributes, and the provision of suitable learning and work space to facilitate student interaction. The focus on real world, relevant issues and problems also serves to promote engineering as essential, exciting and rewarding (Beanland, 2012).

Transformation is partly a political process, and as such may encounter resistance and barriers to change. Universities and academics usually have a focus on research, rather than education, are conservative and resist change, and have a culture and space for lecturing, rather than learning. Universities in general focus on staff performance in terms of papers published and grants gained, and have higher rewards for researchers than effective educators, and university leaders rarely see the need for transformation. Other constraints and barriers relate to accreditation authorities, who tend to be conservative, slow to change, often averse to an output-oriented, graduate attribute approach, and often do not effectively enforce attribute achievement at the individual student level. Despite the rhetoric of excellence, quality, innovation and creativity, there are real concerns, as noted above, regarding declining standards in these areas.

8. Transforming engineering education

There is a particular need to recognise changing needs for engineers, in terms of knowledge, learning, graduate attributes and professional competencies. These include a problem-solving, problem-based learning approach and link to global issues - poverty, sustainability, climate change. There is also a need to promote information, evidence, examples of good practice and advocacy on the need to transform engineering education targeted at engineering organisations, accreditation bodies and universities, to facilitate government support and enlist champions for change and transformation.

It is possible to identify areas of 'transformative action' that are crucial for change. In the case of transforming engineering education, these relate particularly to:

- Knowledge systems – in engineering, science, technology
- Ethical issues – in engineering, science, technology
- Data and information – in/on engineering, science, technology
- Engineering and science education and educators
- Engineering and science professions, institutions, employers
- Policy and politics – decision making and decision-taking
- Society and social context for engineering, science, technology

Guidelines for transformative action in these areas include the need to develop and disseminate a better understanding of the knowledge system of engineering – how knowledge in engineering is produced, applied and disseminated in social, economic and ethical context. This requires data and information on engineering to support evidence-based advocacy for change. This needs to be directed toward engineering and science educators (at tertiary and secondary level), the engineering profession, institutions and industry, policy makers and politicians.

Several areas of transformative action crucial for change in engineering education have been identified. These relate particularly to engineering information, knowledge and ethics, the engineering profession, institutions and industry, engineering educators, engineering policy, planning and decision-making, and the wider social and ethical context for engineering (UNESCO Report, 2010; Beanland and Hadgraft, forthcoming). Specific guidelines for transformative actions include the following:

- Use of the Washington Accord graduate attributes as overall objectives for engineering education, and assessment based on these attributes.
- Use of curricula to develop professional competencies, emphasising student-centred, Problem-Based Learning and ICT resources over lectures to encourage motivation and engagement, especially in first year (for example, the EWB Challenge in Australia).

To facilitate such transformations, actions required include the development of:

- Curricula, establishment of student goals and assessment based on Washington Accord graduate attributes.
- Student-centred, Project Based Learning curricula, featuring use of ICT resources, student learning rooms, e-portfolio personal learning environments and staff as learning facilitators rather than lecturers.
- University-industry cooperation for project activity, work and professional experience, exchange and promotion of engineering as a career.

Possible resistance and barriers to change, and how to address them:

- Universities are conservative – need information, advocacy for change
- Universities focus on research – need more emphasis/reward for education
- Universities focus on lecturing – need to emphasise learning
- University space is for lecturing – need for student learning space
- Accreditation authorities - need to recognise WA graduate attributes

Engineers and educators can help facilitate change by:

- Recognising, promoting and supporting the transformation of engineering education to universities, government, through example, research, information, advocacy
- Working with industry on projects, professional experience and exchange and facilitate transformation
- Working with accreditation authorities and universities to implement Washington Accord graduate attributes, professional competencies and development.

The transformation of engineering education is required to attract and retain young people in engineering, to address the shortages of engineers increasingly reported around the world, and associated brain drain from developing countries, and to keep up with changing needs for engineers, changing modes of knowledge production and application and changing needs in the world. These include the increasing need for sustainability, climate change mitigation and adaptation, and humanitarian engineering to reduce poverty and promote social and economic development – challenges that concern and appeal to many young people, and attract them to engineering.

The transformation of engineering education needs to be student-centred, with a focus on graduate attributes, professional competencies and relevance. This transformation will not only benefit students and engineering, but also universities, industry and the wider public. Other professions, such as medicine, have transformed toward 'patient-based' learning, when there was no enrolment need to do so, wheras engineering has enrolment and retention issues that transformation will address. These issues are internal and external to engineering, and require internal and external incentives to change, including a move from teaching to learning, and a better balance of reward between learning and research at universities. Student-centred, problem- and project-based learning has been shown to facilitate such transformation at various universities around the world (Aalborg, Olin College, Singapore University of Technology), with many other universities taking an interest. Accreditation authorities and governments need to recognise, support and help facilitate the output-oriented, graduate-attributes approach and transformation of engineering education.

9. Engineering studies, policy and planning

The background to the transformation of engineering education relates particularly to government and academic interest in science and science policy and planning, which has neglected engineering. Engineering studies, policy and planning needs to be developed to facilitate the transformation of engineering and engineering education. Interest in science and science policy and planning developed particularly after 1945. Reflecting this interest, courses and then departments focusing on science and technology studies, policy and planning were established in the 1960s at universities around the world. Business schools also developed an interest in science, technology and innovation. Most of this interest focused on science or 'science and technology' policy, with little reference to engineering. The study of engineering, and engineering policy, remained a neglected area of interest and emphasis. This is reflected in the limited public, media and policy awareness, perception and understanding of engineering today. The main reasons that science and technology policy has a focus on science rather than engineering relate to classical economics, public and research policy, and the popular perception and 'linear model' of science and innovation.

In classical economics, technology is regarded as residual, subordinate to the three factors of production - land, labour and capital. Science policy developed from public and research policy, and the principle that decisions regarding the allocation of research funds should be made by researchers rather than politicians – thus favouring science rather than engineering. In the 'linear model' of innovation, basic science research is imagined to lead, through applied science and engineering, to technological application, innovation and diffusion. This model was promoted by Vannevar Bush in the postwar period, and has endeared and endured with scientists and policy-makers on grounds of simplicity and funding success, although many science and technology policy specialists now regard the 'linear model' as inaccurate and misleading. This is partly due to the recognition that many innovations derive from engineering rather than basic science. Interest in the role of science, engineering and technology in international development also evolved towards the end of the colonial period in the 1960s, with the development of universities in developing countries, again with a focus on science, rather than engineering, replicating universities in developed countries.

Given this background, and the rapid change in knowledge production, dissemination and application, there is a particular need to develop a more holistic view of science, engineering and technology, better integrating engineering into the narrow, linear model focusing on the basic sciences. To achieve this, there is a need to emphasize the way engineering, science and technology contributes to social and economic development, and the vital role engineering will plays in promoting sustainability, climate change mitigation and adaptation. There is also a need to better integrate engineering into science and technology policy and planning, and of better integrating engineering, science and technology into development policy and planning, to provide a more useful and accurate reflection and model of reality. This also applies in the development context - engineering, science and technology drive development, are vital in promoting sustainability and poverty reduction, and need to be placed at the heart of policies addressing these issues, at the national and international levels. As noted above, engineering is vital in addressing basic human needs in water supply, sanitation, housing, energy, food production and processing, transportation, communication, income generation and employment creation. Development policy and planning would benefit from a broader approach and 'evidence-based' analysis of the way engineering and technology drives development and reduces poverty. These considerations also relate to the need to transform engineering education to facilitate innovation and development, and the important role of PBL and humanitarian engineering in encouraging the interest, enrolment and retention of young people in engineering in developed and developing countries.

10. Concluding remarks

There is a particular need to recognise the changing context of knowledge production and application, and changing needs for engineers in terms of learning, graduate attributes and professional competencies, as indicated in the Washington Accord. These include a problem-solving, problem-based learning approach and link to global issues – especially poverty, sustainability and climate change. There is also a need to develop and promote information, evidence, examples of good practice, and to enlist champions for advocacy regarding the transformation of engineering education, focusing on engineering organisations, accreditation bodies and universities, with the goal of facilitating government and private sector support for transformation.

To conclude, it is useful also to consider the consequences of failure to address the challenge to transform engineering education. This includes continued shortages of engineers around the world, continued impact on social and economic development, continued brain drain and impact on developing countries, a world of borders without engineers. This is the potential backdrop to the need for engineering education to transform itself to interest young people, promote enrolment and retention, reflecting changing knowledge, production, dissemination and application, changing societal, economic conditions and needs.

References

Appropedia, 2006, the first internet portal on appropriate technology for development, established in 2006.

Beanland, D., 2012, "Engineering Education: the Need for Transformation", presentation to Engineers Australia, Melbourne, 19 July 2012.

Beanland, D., and Hadgraft, R., forthcoming, "Engineering Education: Innovation and Transformation", commissioned by UNESCO, 2010.

Freeman, C, 1995, "The National System of Innovation in Historical Perspective", Cambridge Journal of Economics, No. 19, pp. 5–24.

Hill, Richard, 2012, "Whackademia: An Insider's Account of the Troubled University", University of New South Wales Press.

Lundvall, BA, (ed), 1992 "National Innovation Systems: Towards a Theory of Innovation and Interactive Learning", Pinter, London.

Marjoram, 2010, UNESCO Report, 2010.

Metcalfe, S, OECD-UNESCO, 2009, keynote presentation at the, OECD-UNESCO International Workshop, "Innovation for Development: Converting Knowledge To Value", OECD, Paris, 28-30 January 2009, co-hosted by the OECD and UNESCO. See also Metcalfe, S. (1995), "The Economic Foundations of Technology Policy: Equilibrium and Evolutionary Perspectives", in P. Stoneman (ed.), Handbook of the Economics of Innovation and Technological Change, Blackwell Publishers, Oxford.

Mondialogo, 2010, Daimler-UNESCO Mondialogo Engineering Award, UNESCO Report, 2010.

National Science and Technology Centre, Australia, 2007, personal communication, Brenton Honeyman, World Conference on Science and Technology Education, Perth.

Obama, 2008, 2013, Presidential Inaugural Addresses, the first emphasizing the importance of engineering in infrastructure redevelopment, the need for more engineers and need to invest in engineering, the second mentioning the ongoing need for engineers and need to increase immigration.

Paul Polak, 2010, "The Death of Appropriate Technology: If you can't sell it, don't do it", "Out of Poverty".

Sachs, 2000, Economist, "Globalisation: A New Map of the World", Sachs argues that today's world is divided not by ideology but by technology.

Schumacher, E. F., 1973, "Small is Beautiful: Economics as if People Mattered", Blond and Briggs, London; regarded as one the 100 most influential books published over the last 50 years (Times Literary Supplement).

UNESCO Report, 2010, "Engineering: Issues, Challenges and Opportunities for Development".

UNESCO, ITDG, TVE, 2004, "Small is Working: Technology for Poverty Reduction", video and 70-page booklet to commemorate E.F. Schumacher, "Small is Beautiful: Economics as if People Mattered", 1973.

Washington Accord - an international agreement established in 1989 recognising equivalencies in accreditation for professional engineering academic degrees between national bodies responsible for accreditation in its signatory countries. Signatories in 2010 included Australia, Canada, Chinese Taipei, Hong Kong China, Ireland, Japan, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, the UK and USA.

Yamani, A. Z., 1973, quotation from Sheikh Yamani, Saudi Minister for Oil, at OPEC.

Implementation of Project-Oriented Problem-Based Learning (POPBL) in *Introduction to Programming* Course

Noraini Ibrahim [a] *, Shahliza Abd.Halim [b]

[a-c]*Faculty of Computing, Universiti Teknologi Malaysia, Skudai 81310, Johor, Malaysia*

Abstract

Project-oriented problem-based learning (POPBL) is one instructional methodology that has been widely applied in many other Teaching and Learning (T&L) activities. POPBL incorporates the development of students' personal skills and also promotes creativity in any given T&L environment. In this work, a POPBL that would be implemented in *Introduction to Programming* course taught at Universiti Teknologi Malaysia is presented, as well as discussion concerning the students' results and overall achievement. The results gained have depicted that POPBL is very much applicable to be implemented even for freshmen in Computing field; that is also intended to expose the students with more problem-solving skills especially in the real-world business application systems.

Keywords: Introduction to Programming, Project-oriented problem-based learning (POPBL), Teaching and Learning (T&L) activities, Teamwork;

1. Introduction

The Project-oriented problem-based learning (POPBL) model is believed to be originated from the Aalborg University, Denmark, and it is currently available for the past thirty years (Hussain & Rosenørn, 2008). POPBL approach is one kind of instructional methodology in teaching pedagogy model that was initially adopted from Problem-Based Learning (PBL) (Lehmann, Christensen, Du, & Thrane, 2008) (Uziak, Oladiran, Eisenberg, & Scheffer, 2010). Thus the POPBL implementation has its basis from the PBL model with the three important and inter-related components that make-up the POPBL model in T&L approach, namely i) problems, ii) project and iii) team work (Du & Jensen, 2010).

Upon relating POPBL and teaching pedagogy, the effective T&L activities should centre around students; by highlighting students-centred and active learning while encouraging students to learn how to learn (Moesby, 2005) regardless the lecturers' ability to complete the syllabus in time (Ahmad & Jabbar, 2007; Du & Jensen, 2010; Yasin & Rahman, 2011). Nevertheless, implementation of POPBL should also expose the students on their roles and responsibilities to ensure that the level of understanding is not only based on "Just-in-Time" knowledge but also to motivate the learners to think aloud and "Think-out-of-the-Box" (Abdul Ghafir, Hasnan, Khalid, & Mohd Ali, 2007; Ahmad & Jabbar, 2007; Mohamed, Mat Jubadi, & Wan Zaki, 2011). In addition to that, the technical skills in creatively providing solutions to solve the given problems according to the engineering, science and mathematics theories that the students have learnt prior, must also be accompanied with non-technical skills or soft-skills such as the ability to effectively cooperate and communicate with team-mates, as well as the ability to efficiently manage and plan for the project to ensure the success of POPBL adoption in T&L activities (Lehmann et al., 2008).

Currently, there are various numbers of POPBL implementation among teachers. Among the approaches are mainly applied on engineering courses as in Electrical Power Systems Engineering (Hosseinzadeh & Hesamzadeh, 2012), Switching-Mode Power Supplies (Lamar et al., 2012) and Wind Energy (Santos-Martin, Alonso-Martinez, Eloy-Garcia Carrasco, & Arnaltes, 2012) or hardware related subjects as in Programmable Logic Design and Computer Architecture (Kellett, 2012), Analog Electronic (Mohamed, Mat Jubadi, & Wan Zaki, 2012). Similarly, the POPBL implementation onto these kind of subjects have significant differences compared to Software Engineering (SE) related subjects (Qiu & Chen, 2010) ; as it deals with products related to SE which are easily changeable due to its malleable characteristics and complexity due to its relation with other domain (Richardson, Reid, Seidman, Pattinson, & Delaney, 2011). From computing and software engineering field, the importance of POPBL is also undeniable due to future scenarios that learners have to face in their workplace as computer scientist and software engineer; when they have to develop software as an effort to solve real-world problems, exploring creatively the possible solutions and independently undergoes lifelong learning to cope with rapid changing computing technologies nowadays.

This paper describes on our previous experiences in POPBL implementation and its outcome results for an undergraduate course taught at the Faculty of Computing, Universiti Teknologi Malaysia, titled *"Programming Technique 1"*. The POPBL experimentation was conducted recently during Semester 1, 2012/2013 session. Also, the test-bed was carried out with approximately 41 total students for the 2 participated sections from 8 sections of overall course enrolment. It is satisfactorily enough to collect the students' perceptions when 40 from 41 participated students have completed the self-regulated questionnaire for the POPBL exit-survey at the end of the semester.

* Corresponding Author name. Tel.: +607-5532435
E-mail address: noraini_ib@utm.my

This paper is organised as follows. In Section 2, a brief introduction on the course and the POPBL adaptation are provided. Next, Section 3 presents the overview on the results of POPBL implementation, as well as the discussion on the outcome and students/lecturers reflections. Finally, some overall remarks are provided in Section 4.

2. Introduction to *Programming Technique* Course

In this section, the related course and the methodical process in POPBL implementation are presented. The following section 2.1 discusses the *Programming Technique 1* course structure in details, while section 2.2 describes the planned tasks and activities in POPBL implementation accordingly.

2.1. Description

SCSJ1103 Programming Technique 1 course is the first Programming course offered to the first semester and first year students at Faculty of Computing in Universiti Teknologi Malaysia. The course is centred on an introduction to programming technique foundation using C++ language. Additionally, as a fundamental subject, this course equips the students with theory and practice on problem solving techniques by using the structured approach. Students are required to develop programs using C++ programming language, in order to solve simple to moderate problems.

The course covers the following: pre-processor directives, constants and variables, data types, input and output statements, text files, control structures: sequential, selection and loop, built-in and user-defined functions, one dimensional and two dimensional array.

The course is contextually designed so that by the end of the course, students should be able to achieve the following learning outcomes (**LO**s):

LO1 : To solve problems systematically using problem solving methods.
LO2 : To construct a C++ program correctly from the analysed problems using structured approach.
LO3 : To construct or develop complete C++ programs for simple to moderate problems individually.
LO4 : To solve problems in a given time frame using C++ programming language and tools.

Table 1 shows the summary of current curriculum for the *SCSJ1103 Programming Technique 1* course. Basically, in one particular week, lectures (2 hours) and lab tutorials (2 hours) are conducted approximately for 14 weeks. Students have to critically and analytically solve the same problems of the given case study application throughout the semester. There are 3 main assessments which to be performed according to the stated phases in Table 1.

Phase 1 covers from the very first topic until specific topic related to the problem solving process and techniques for 4 weeks. Later in phase 2, the related topics that focused on the C++ programming concepts such as variables, constants, arithmetic expressions, input/output operations, control structures (branch and loop) are covered for about 5 weeks. In this last phase 3, students are exposed to the 2 medium level concepts in C++ programming, namely; function and array (1- and 2-dimensionals).

Table 1. Course syllabus and POPBL stages

Week	Syllabus/Topic	Assessment/Phase
1	*Introduction to computer & programming*	I : Problem analysis and design
2	*Problem solving process*	
3 & 4	*Problem-solving techniques*	
5	*Introduction to C++*	II : Development & Testing
6	*Arithmetic Expression & Input/output operations*	
7	*Control structure: Selection/Branch*	
8 & 9	*Control structure: Repetition/Loop*	
10	Semester break	
11&12	*Function*	III: Re-development (Evolution) & Testing
13	*Array 1-dimensional*	
14 &15	*Array 2-dimensional*	

2.2. Implementation of Project-Oriented Problem-Based Learning (POPBL)

Our designed POPBL framework, as shown in Figure 1 below, basically consists of three main stages:

1. Onset : Setting the project context – team, defining the case study problems as well as collecting students learning style (correlation to students performance)
2. Execution : Implementation of three assessments based on software development life-cycle (SDLC) stages
3. Closure : Conducting post-mortem, review & exit survey (analyzing the end results of POPBL implementation)

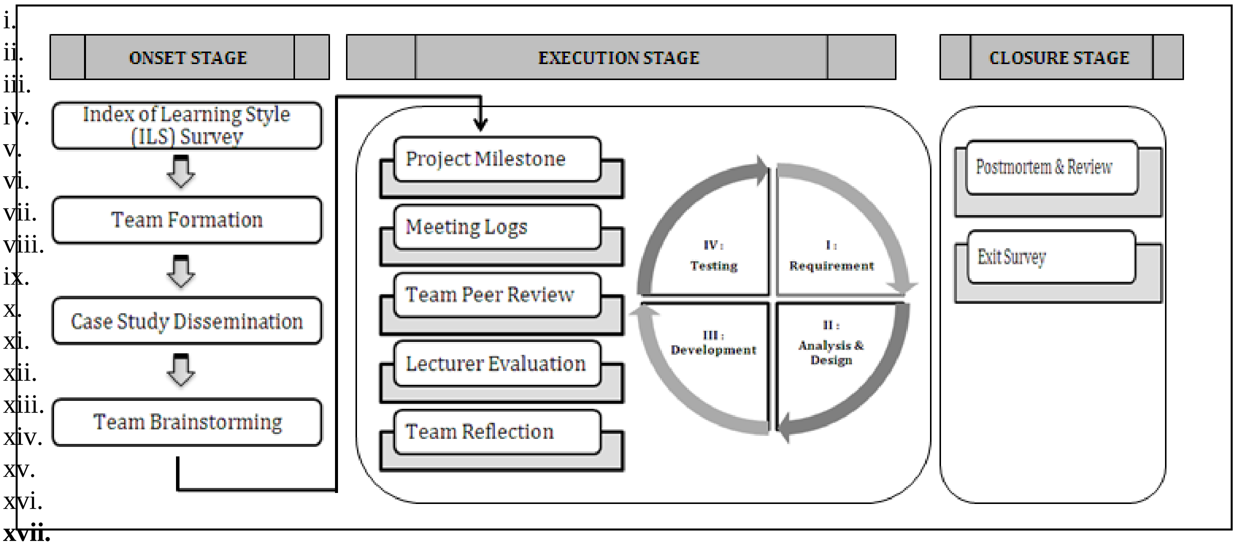


Figure 1. POPBL Framework Design

The proposed framework is tailor-designed so that it is similar to the basic stages in SDLC; requirement, analysis, design, development, and testing phases, as illustrated in *Execution* stage. Like other works similar to POPBL implementation, our students have been given a problem in the context of software application development project as a real-world case study. Students were allocated into a team with three/four members. Based on the designed POPBL framework, the project started from: i) eliciting requirements and analyzing the case study problems, ii) designing and proposing the applicable solutions for the given case study, iii) implementing and developing the software application based on the design product components, and finally iv) testing the developed project to ensure that the product meets the desired quality.

Every team was given different case study problems to be analyzed throughout the whole semester. There are three cycles/assessments for the given case study project. At the same time, the complexity of problems in the case study was gradually increased for each assessment. This is to ensure that complexity is mapped to the students' exposure and knowledge are synchronized to the planned curriculum syllabus and course topics (Refer to Table 1).

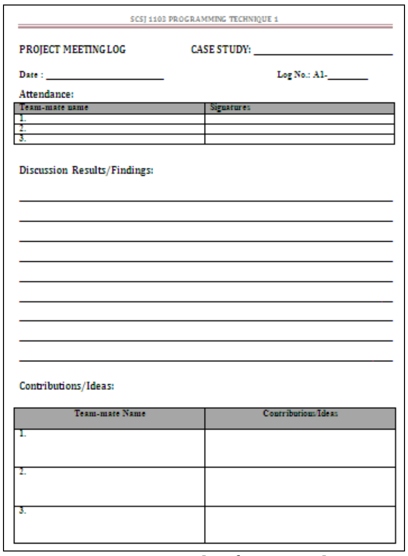
Generally, Table 2 depicts the mapping between the course syllabus (in Table 1) and the POPBL implementation in practices. The POPBL implementation contributes approximately 15% from the overall coursework. For all three stages, two mandatory milestones are the meeting logs and the peer-review assessment forms (Figure 1 and 2); which contribute for 3% from 15% total grading of the project.

Based on Table 2, in the first phase, each team should submit the first milestone namely; the proposed problem designs and solution for the case study report (4%). During the second phase, students are guided and monitored to ensure that the second milestone deliverability, which was a small-scale application for the given case study, is developed based on aforementioned C++ language concepts (Week 5 till 9 in Table 1). The success of the second milestone development is crucial to proceed to the next final phase of POPBL implementation. Within five weeks, each team should deliver their third milestone; the improvised application from second milestone that applied these two concepts (functions and arrays).

The idea on referring to meeting logs are intended to monitor and to track teams' progress; ensuring that the team formation works and to ensure cooperation with other team-mates. In meeting logs, as illustrated in Figure 2, teams have to report their meeting findings and team-mates' contributions in every discussion. In order to ensure that the fair evaluation is made in assessing the team-working efforts, the peer-review assessment is introduced. Figure 3 shows the five basic criteria, namely; cooperative, hardworking, punctuality, knowledge sharing and good personality are assessed among the team-mates. By giving three chances for each phase, this peer-review assessment really helps to see the students' patterns in evaluating their team-mates.

Table 2. POPBL stages and assessments

Phase	Assessments/ Milestones	LOs	Grading
I : Problem analysis and design	a. Meeting logs (at least once a week)	LO1, LO2	0.5%
	b. 1st Peer-review assessment		0.5%
	c. Report document (Proposed problem designs and solutions; pseudo-codes & flow-charts)		4.0%
II : Development & Testing	a. Meeting logs (at least once a week)	LO3, LO4	0.5%
	b. 2nd Peer-review assessment		0.5%
	c. Report document (Problems discussion, C++ theory & concepts realization, reflection & findings, and user interface snapshots)		1.0%
	d. Mini (small-scale) application/system		3.0%
Semester break			
III: Re-development (Evolution) & Testing	a. Meeting logs (at least once a week)	LO3, LO4	0.5%
	b. 3rd Peer-review assessment		0.5%
	c. Report document (Problems discussion, C++ theory & concepts realization, reflection & findings, and user interface snapshots)		1.0%
	d. Improved mini (small-scale) application/system		3.0%


SCSJ 1103 PROGRAMMING TECHNIQUE 1

PROJECT MEETING LOG CASE STUDY: ____________

Date : ____________ Log No.: A1-______

Attendance:

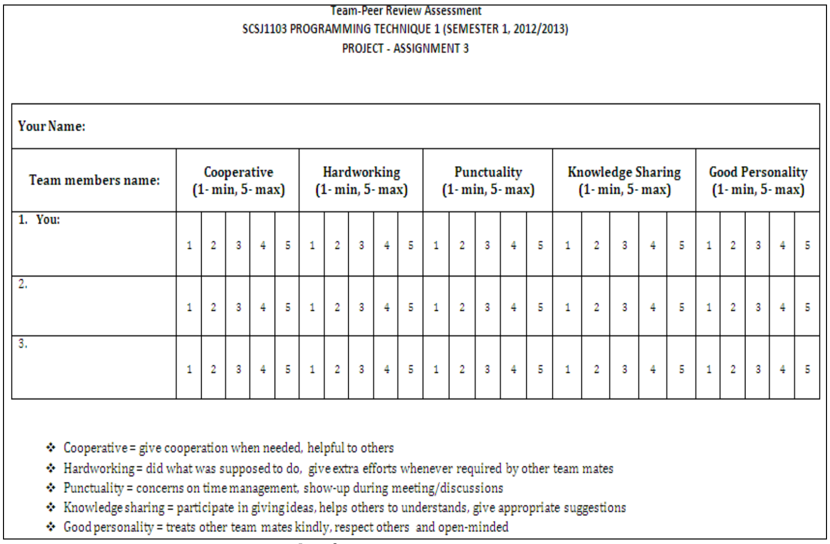
Team-mate name	Signature
1.	
2.	
3.	

Discussion Results/Findings:

Contributions/Ideas:

Team-mate Name	Contribution/Ideas
1.	
2.	
3.	

Figure 2. Example of Meeting log


Team-Peer Review Assessment

SCSJ1103 PROGRAMMING TECHNIQUE 1 (SEMESTER 1, 2012/2013)

PROJECT - ASSIGNMENT 3

Your Name:

Team members name:	Cooperative (1- min, 5- max)					Hardworking (1- min, 5- max)					Punctuality (1- min, 5- max)					Knowledge Sharing (1- min, 5- max)					Good Personality (1- min, 5- max)				
1. You:	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3.	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

- Cooperative = give cooperation when needed, helpful to others
- Hardworking = did what was supposed to do, give extra efforts whenever required by other team mates
- Punctuality = concerns on time management, show-up during meeting/discussions
- Knowledge sharing = participate in giving ideas, helps others to understands, give appropriate suggestions
- Good personality = treats other team mates kindly, respect others and open-minded

Figure 3. Example of Peer-Review Assessment Form

3. Outcome, Results and Discussion

In this section, the outputs in terms of the overall outcomes, the students' feedbacks results and the discussion for the implemented POPBL experimentation in the previous SCSJ1103 course are presented. The survey questionnaires are developed and mapped to the previous designed POPBL implementation framework as mentioned in section 2.2. The questionnaires are designed to measure the three main perspectives to be achieved in the POPBL framework components, namely; i) cognitive learning, ii) collaborative learning, and iii) contents; with a total of twenty-seven questions being asked to assess the students' feedbacks on these three components.

Forty from forty-one total students have successfully participated in the survey at the end of the semester, as mentioned in section 1.0 earlier. Most of the questions which are mapped to the acquired criteria for the three POPBL components, are measured through five Likert scales: 1-Strongly disagree, 2-Disagree, 3-Undecided, 4-Agree, and 5-Strongly Agree. However, the case study understanding is measured by: 1-Not Understood, 2-Poorly Understood, 3-Fairly Understood, 4-Well Understood, and 5- Highly Understood. Also, for the last criteria in rating the real-problems complexity, the scale is ranged from:1-Very Easy, 2-Easy, 3-Average, 4-Difficult, and 5-Very Difficult.

3.1. Discussion Results on Cognitive Learning Perspective

In terms of learners' cognitive learning perspective, there are three main categories being measured, namely; analytical and problem solving skills, project management and planning skills, as well as learners knowledge improvement. The following Table 3 presents the related questionnaires for the cognitive learning perspective respectively with the categories and the criteria. Additionally, the following Figure 3, 4 and 5 shows respectively the students' response and the distribution frequencies (from N=40) for three categories of cognitive learning perspective; analysis & problem solving, project management & planning, and learners knowledge. In summary, almost 85% of the students agreed (from agree to strongly agree scales) that the POPBL implementation in the SCSJ1103 coursework is helpful in terms of analysing and providing solutions towards the given real-world problems, managing and planning their project progress, and improving learners' experiences, knowledge and creativity in doing the project.

However, some remark notes can be observed for criteria no.3, which is related to the students' ability to solve the case study problems in a specific time period. There are about 15% students who did not sure that they can commit on the given period and gave feedbacks that they are hoping for a longer duration in submitting the deliverable especially during third stage where the related topics of Function and Arrays (refer to Table 1) are quite difficult to understand for their level as first semester students. As for criteria no. 5, 22.5% students were undecided whether the POPBL implementation allows them to perform self-directed learning to become more creative and analytical.

Table 3. Cognitive learning categories and criteria

Cognitive Categories	Criteria
Analytical and Problem Solving	1. Enabled me to analyze and design solutions for the given real-problem case study
	2. Enabled me to develop models based on the structured development technique for the analysis and design of the case study
	3. Enabled me to solve the real world case study within a given time period.
	4. Enabled me to gain deeper understanding of the topics and acquire higher skills in problem solving.
	5. Has been effective in advancing my self-directed learning to become more creative and analytical in solving real-problem
	6. I am able to continue life-long learning, independent research and apply structured development technique in real life.
Project Management and Planning	7. The given time and effort required to complete assignment one by one towards the completion of my project was reasonable.
	8. I was exposed to be responsible towards my team by allocating specified task to each member.
	9. Switching roles among the team members during the assignment and towards the project completion is a good idea to delegate the tasks fairly.
	10. Delivering meeting logs in specific duration times enabled the team members to show project progressions and to work as a team.
Learners Knowledge	11. I am able to experience system development life cycle (requirement, analysis, design and implementation) during problem solving and application development for the case study.
	12. I am exposed to the basic knowledge for developing system application in my study and my future workplace.
	13. I have learned from the mistakes I have made each time the lecturer assess my assignments and presentations.
	14. I am given chance to think creatively and out-of-the-box.
	15. I am able to demonstrate proficiency in analyzing and solving problems through relevant information gathering methods, using analysis and design techniques and tools and doing independent research.

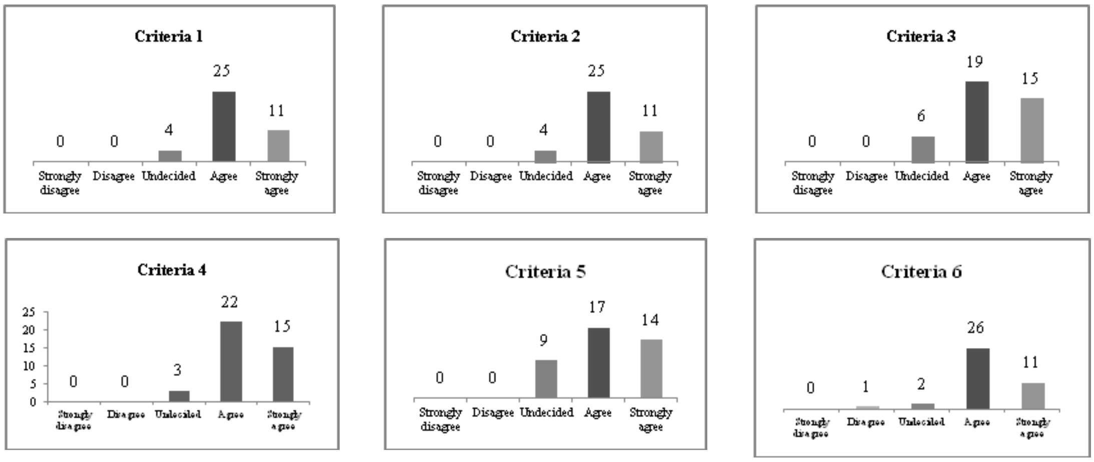


Figure 3. Analytical & Problem Solving : Criteria 1-6 Results

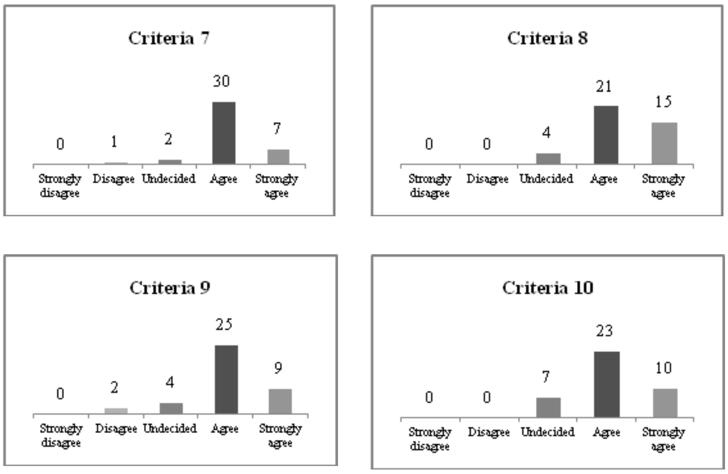


Figure 4. Project Management &Planning : Criteria 6-10 Results

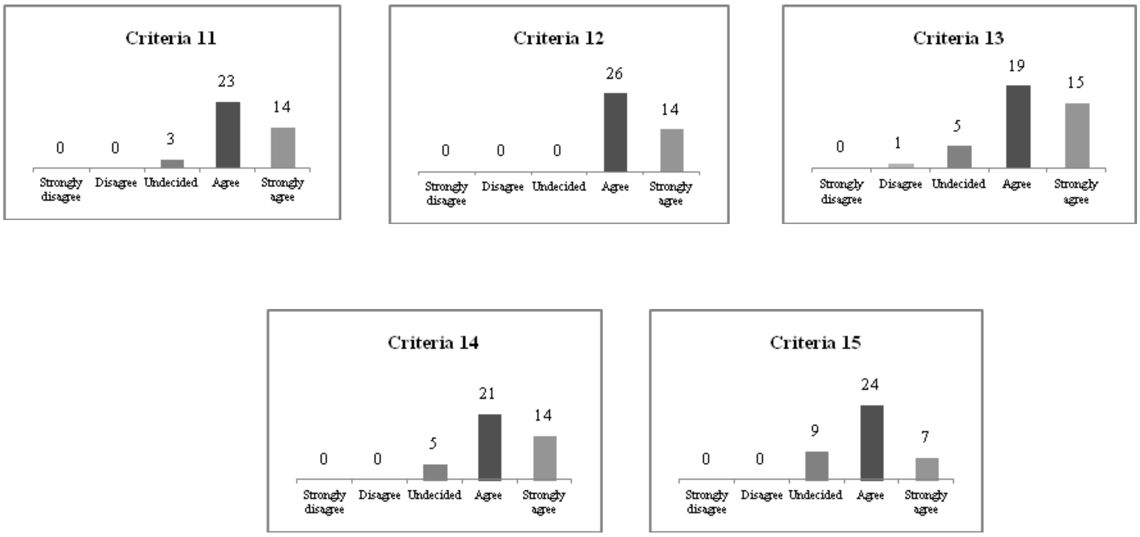


Figure 5. Learners Knowledge : Criteria 11-15 Results

3.1 Results on Collaborative Learning Perspective

Table 4 presents the related questionnaires for the cognitive learning perspective. In overall, based on Figure 6, the frequency distribution ranging from the lowest 72.5%, average 77.5%, and highest 87.5% students agreed with the collaborative learning perspective for POPBL implementation in their projects. However, it is interesting to observe that there are several small frequency distributions especially for criteria 19 and 22. Approximately 27.5% or less than eleven students who were still struggling to cooperate with their peers (criteria no.19). This might be an indicator that the current activities should be integrated with newly interactive activities that allows team-working functions as planned to exist at beginning of the project.

A small portion of students' distribution in criteria 22 were found disagreed (2.5%) and undecided (10%); that interaction between peers and his/her team helps in completing the task. From closed-observation based on questionnaires feedbacks, it is found that these students have commented that they could not voice out – verbally and directly – if any one of their team-mates were not giving commitment and cooperation while conducting the project.

Table 4. Collaborative learning criteria

Perspective	Criteria
Collaborative Learning	16. I am actively participating in giving ideas, help others to understands, give appropriates suggestions during team discussions.
	17. I am able to evaluate, communicate and express knowledge and ideas effectively, professionally and ethically.
	18. I am able to compete with each other to find the best solutions.
	19. I am responsible towards my team progression, and work in team makes me work hard to contribute more in team.
	20. I am able to learn how to use my strengths in a constructive way while improving on the weaknesses of my team members.
	21. I am able to give cooperation when needed and helpful to others.

	22. Peers and team interactions is very useful to me in completing the task.

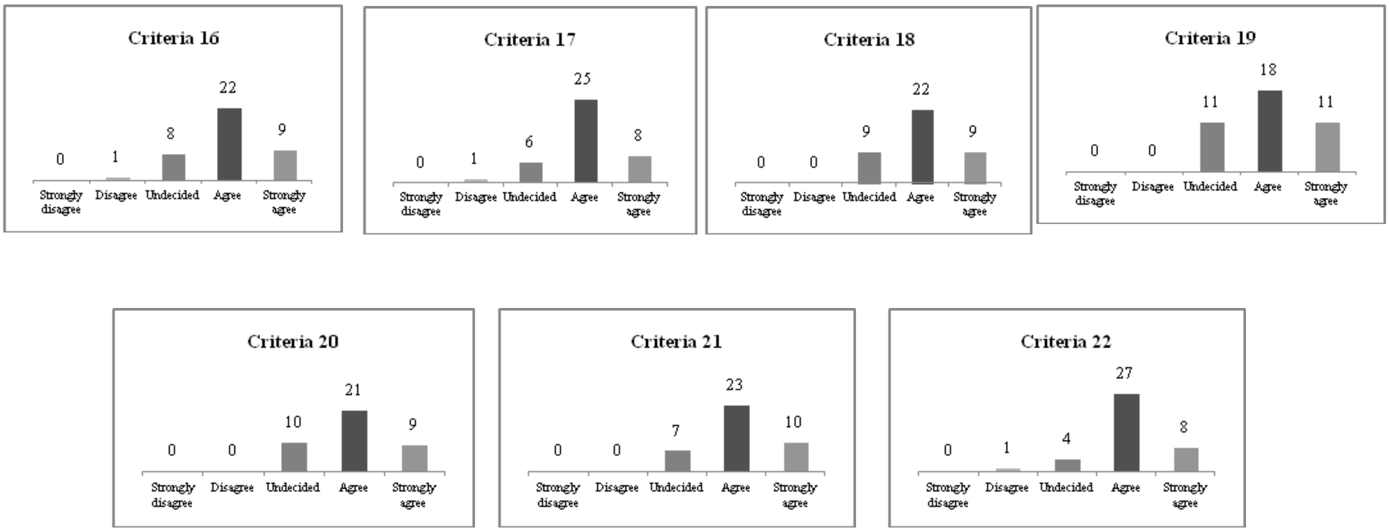


Figure 6. Collaborative Learning : Criteria 16-22 Results

3.2 Results on Contents Perspective

Table 5 presents the content perspective in terms of instructor monitoring and guidance role, the mapping on course syllabus with POPBL approach, the students' understanding on given case study and the real-problems complexity level of the given case study criteria. As for survey results, Figure 7 portrays the 100% distribution of students who agreed that the lecturer (instructor) played a major role in monitoring and guiding towards the POPBL implementation. Additionally, all students also agreed that the *Programming Technique 1* coursework syllabus is appropriately suitable to be adopted for POPBL approach.

Apart from that, it is found that from the frequencies recorded in criteria 26 and 27 which relate to the given case study and the real-problems under focus, the students generally understood the overall case and problems. Basically, for both sections 04 & 07 of this coursework, six case studies application (app.) were chosen, namely; i) Daily water intake app., ii) Priority quadrant app., iii) Know your learning style App., iv) GPA calculator app., v) Monthly budget planner app., vi) Calories counter app. The mentioned case studies were selected based on current experiences and students' lifestyles. Students can search for similar app. from the Internet or simply observe the system functionalities based on their real needs as students. However, none of the students agreed that the real-problems complexity of the case study was indeed easy. Majority of the students chose average, while 42.5% of the distribution found the case study to be difficult.

Table 5. Content categories and criteria

Content Categories	Criteria
Instructor Monitoring Role	23. The instructor/lecturer contributes and play roles in monitoring the teams progression and achievement.
Instructor Guidance Role	24. The instructor/lecturer expresses and describes clear guidance about the implementation of POPBL in the course.
Course Syllabus Mapping	25. The course syllabus is appropriate and suitable to be adopted for the POPBL approach.
Understanding Case Study	26. In overall, estimate how well you understood the given case study application; in terms of its environment and functionality.
Real Problems Complexity	27. In terms of the given case study, estimate overall difficulty and complexity on the real-problems you have been asked to solve.

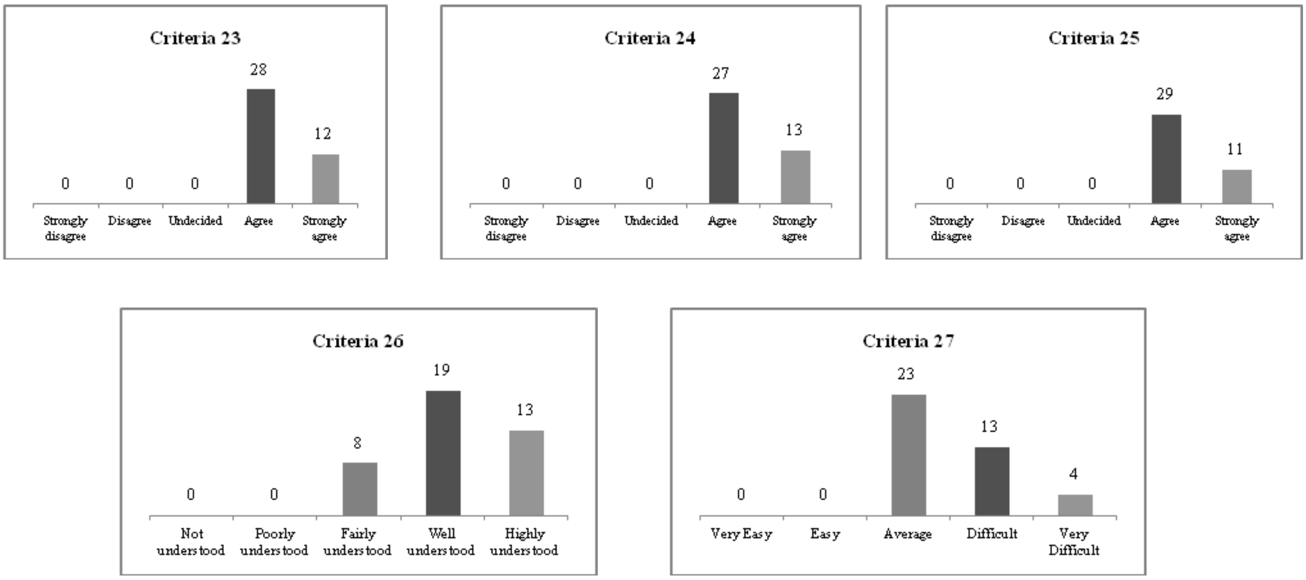


Figure 7. Content Perspective : Criteria 23-27 Results

3.3 Students Responses and Feedbacks

Some significant positive and negative responses and feedbacks are presented in the following Table 6. From our closed observation based on the conducted survey, it is found that the students' achievement is very much depending on numbers of factors such as: i) prior background intake (CGPA), ii) participation during teaching and learning (T&L) activities, and iii) motivation towards gaining more knowledge rather than achieving a good grade only. Also, it is observed that the excellent students (those who scored A+, A, A-) would give good comments and credits to the conducted T&L activities during POPBL implementation in their project. In contrast, the moderate or less-performing students would normally criticise the teaching methods and materials delivery which they regarded as the source contributors towards their achievement.

Table 6. Sample of students responses and feedbacks

Positive response & feedback	Negative response & feedback
Create teamwork amongst student, generate skill in programming also as a software engineering student. As a practice of real case study when we going to face a job-time after this.	Some members does not try to give efforts and just follow the others members.
Enable students to work in teams of different personalities and able to manage time more seriously. Students can become more tolerant towards others as well as forced to prioritize project(which is in a good way) as the marking does not only concern oneself but the whole team.	Lecture should already given what part should each member do, so that we know he/she do his/her work. if like now, a good member need to backup the lazy member work because the assignment's mark is in group so by hock or by crook the good member need to complete the assignment.
Strength of this POPBL is know how to work in team mates and faces the attitudes of each person. also, learn a programming skill that need to be implement in the program.	Some of the group member doesn't show enough effort. This is because of their skill is weak and don't want to improve it. Also, the topic that we are given is not a student wish. We should be able to create own topic and refer to lecturer whether it suitable or not.
Major strengths would be the type of application assigned to us, how it is actually a real-life application. How we have to incorporate elements in programming throughout the assignments. It help us develop our skills progressively.	Some of the POBL task requires the implementation of complex function such as arrays which is only taught at the end of the semester. This makes it hard to start the project because lack of knowledge on given function.
Make me more cooperate in the group and share ideas to solve problem that we have faces. Beside, give me more knowledge about what I learn in class then apply to project that given to me. It work.	Student are not familiar with this POPBL so at the beginning of the project student are a bit loss about what to do. =)
POPBL prepared student with the overview of how real-life working environment when dealing with real life case study where the student will eventually face when they work later. this also help develop student critical thinking.	The level of the case study is pretty high to solve especially when to use function and array. sometime team member are not cooperate well.

4. Conclusion and Future Works

This paper reports our very first experience of implementing POPBL approach in *Introduction to Programming* coursework. The previous experimentation with POPBL was initially aimed to provide student-centred and active learning environment which promotes improvement for students' ability in analysing and solving real-world problems related to the current issues in software development. We have also targeted to induce motivation in terms of teamwork and other important soft skills such as communication and self-directed learning.

Based on high achievement for students' results, it is proven that POPBL is suitable to be implemented in the programming course. POPBL approach was implemented as a project-based, where students were given a real-world problem for specific case study applications and current in-trend software which is complex enough for beginner students. Students were assigned in a team to solve the identified problems of the selected case study application throughout the three phases in POPBL. The results findings from the conducted survey have shown that students are highly motivated and satisfied with POPBL implementation towards improving their soft-skills (communication between teammates and planning) as well as their technical skills (analysing real-world problem, designing the structured solutions and developing the products). However, POPBL implementation will require enormous effort and preparation from instructor (lecturer). Thus, assistance from tutor or Teaching Assistant to give a hand in observing and tracking performance for each team member in terms of meeting log, peer-review evaluation, and project progress should take place to ensure the success of POPBL implementation.

In future, it is hoped that our experiences on POPBL implementation in the *Introduction to Programming* coursework for freshman students, could motivate ourselves as well as other instructors/teachers in Computing field especially, to apply this pedagogical approach in our T&L activities. Furthermore, the proposed POPBL procedural framework and its implementation should be custom-designed to be applied in other coursework in terms of the complexity level for the given real-world problem based on students' year of studies and exposure.

Acknowledgements

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References

Abdul Ghafir, M. F., Hasnan, K., Khalid, A., & Mohd Ali, M. F. (2007). *Cub prix experience: a case study on implementation of POPBL in UTHM.* Paper presented at the 2nd Regional Conference on Engineering Education (RCEE), Johor Bahru.

Ahmad, A., & Jabbar, M. H. (2007). *POPBL experience: a first attempt in first year electrical engineering students.* Paper presented at the 2nd Regional Conference on Engineering Education (RCEE), Johor Bahru.

Du, X., & Jensen, L. P. (2010). Project-Organised and Problem-Based Learning [Electronic Version]. Retrieved December 2012, from http://www.control.aau.dk/~lpj/POL/Kursusnavn.html

Hosseinzadeh, N., & Hesamzadeh, M. R. (2012). Application of Project-Based Learning (PBL) to the Teaching of Electrical Power Systems Engineering. *IEEE Transactions on Education, 55*(4), 495 - 501

Hussain, D. M. A., & Rosenørn, T. (Eds.). (2008). *Assessment of Student Competencies for a Second Year Operating System Course*. Rotterdam The Netherlands: Sense Publishers.

Kellett, C. M. (2012). A Project-Based Learning Approach to Programmable Logic Design and Computer Architecture. *IEEE Transactions on Education, 55*(3), 378-383.

Lamar, D. G., Miaja, P. F., Arias, M., Rodriguez, A., RodrÃguez, M., VÃ¡zquez, A., et al. (2012). Experiences in the application of project-based learning in a switching-mode power supplies course. *IEEE Transactions on Education, 55*(1), 69-77.

Lehmann, M., Christensen, P., Du, X., & Thrane, M. (2008). Problem-oriented and project-based learning (POPBL) as an innovative learning strategy for sustainable development in engineering education. *European Journal of Engineering Education, 33*(3), 283-295.

Moesby, E. (2005). Curriculum development for project-oriented and problem-based learning (POPBL) with emphasis on personal skills and abilities. *Global J. of Engng. Educ, 9*(2), 121-128.

Mohamed, M., Mat Jubadi, W., & Wan Zaki, S. (2011). An Implementation of POPBL for Analog Electronics (BEL10203) Course at the Faculty Of Electrical and Electronic Engineering, Uthm. *Journal of Technical Education and Training, 3*(2).

Mohamed, M., Mat Jubadi, W., & Wan Zaki, S. (2012). An Implementation of POPBL for Analog Electronics (BEL10203) Course at the Faculty Of Electrical and Electronic Engineering, UTHM. *Journal of Technical Education and Training, 3*(2).

Qiu, M., & Chen, L. (2010). *A problem-based learning approach to teaching an advanced software engineering course.* Paper presented at the IEEE Second International Workshop on Education Technology and Computer Science (ETCS).

Richardson, I., Reid, L., Seidman, S. B., Pattinson, B., & Delaney, Y. (2011). *Educating software engineers of the future: Software quality research through problem-based learning.* Paper presented at the 24th IEEE-CS Conference on Software Engineering Education and Training (CSEE&T).

Santos-Martin, D., Alonso-Martinez, J., Eloy-Garcia Carrasco, J., & Arnaltes, S. (2012). Problem-based learning in wind energy using virtual and real setups. *IEEE Transactions on Education, 55*(1), 126-134.
Uziak, J., Oladiran, M. T., Eisenberg, M., & Scheffer, C. (2010). International team approach to Project-Oriented Problem-Based Learning in design. *World Transactions for Engineering & Technology Education, 8*(2), 137-144.
Yasin, R. M., & Rahman, S. (2011). Problem oriented project based learning (POPBL) in promoting education for sustainable development. *Procedia-Social and Behavioral Sciences, 15*, 289-293.

Reconstructing the Aalborg Model for PBL

- a case from the Faculty of Engineering and Science, Aalborg University

Anette Kolmos [a*], Jette E. Holgaard [a], Bettina Dahl [a]

[a]UNESCO Chair of Problem based learning in Engineering and Science
Department of Development and Planning, Aalborg University
Vestre Havnepromenaden 5,1st, 9000 Aalborg

Abstract

Aalborg University (AAU) has been one of the front-runners showing the way forward for the establishment of a problem based and project organised environment and in 2010, a new PBL model and a rather comprehensive curriculum restructuring took place at the Faculty of Engineering and Science at AAU. Therefore this paper focuses on what this implementation process can tell us about the drivers, challenges and prospects of reconstructing PBL curricula? We address this question by reporting on the experiences from the middle management level based on interview with three school leaders and 11 study board directors. Based on the results, we stress that although innovations obviously have to happen at a certain pace in order to reflect the state of art in society, the pace have to be adjusted to make room for i) pedagogical support and training, ii) a strong coordination to assure an aligned curricula iii) appropriation of the model to local contexts iv) a strong awareness of the difference in the pedagogical methods and the interplay between them. In relation to the last point, different PBL models with different combinations of project, course and case modules are described and discussed.

Keywords: Curriculum development, implementation processes, PBL models.

1. Introduction

Aalborg University, Roskilde University (both Denmark), Maastricht University (the Netherlands), and McMaster University in Canada were all founded in the 1960s and 1970s where the reform pedagogy originated and they have all established university programs within a problem based and project organised (PBL) practice. The four universities have different PBL models, but basically the same learning principles count: problems, teamwork, self-directed and student centred learning, exemplary learning and not least inter-disciplinary in problem analysis and problem solving. These learning processes can then be organized in slightly different ways, e.g. in projects or cases (de Graaff & Kolmos, 2007).

But having established a PBL model once does not mean that the educational prospect therefore is fixed and finished. It is no longer enough (and probably never has been enough) to initiate one radical change from e.g. a traditional model to a more student centred model such as problem based and project based learning. We also need to make on-going adjustments and changes to keep up with internal as well as external political and societal demands and to develop and influence such societal changes.

Those reform universities have undergone phases of change. Neville and Norman (2007) describe three phases of major curriculum change at McMaster University. The change at the medical school that illustrates the dilemma between a more conceptual and disciplinary focus versus a more contextual focus. This is a discussion that most PBL programs and universities can recognise, as this is a core element in the difference between a traditional academic curriculum and a PBL curriculum. At Aalborg University, there is a long tradition for contextualising disciplinary knowledge as an integrated part of the PBL philosophy (see Jamison & Holgaard, 2008), and the PBL model is internationally recognised for its far-reaching PBL pedagogy. However, the Aalborg PBL model is challenged for several other reasons, which had led to a more substantial systemic change in 2010.

AAU has been one of the front-runners for the establishment of a PBL environment. Descriptions of the AAU PBL learning principles by an external consultant are presented in the booklet “Principles of Problem and Project Based Learning - The Aalborg PBL model” (Barge, 2010). The PBL elements described by Barge (2010) have been used in an internal benchmarking exercise and, as such, served as an internal and external signal of how a PBL model may look like. But this process also sheds light on the diversity in the interpretation and practise of PBL at AAU, which questions if there is in fact *one* dominant PBL Aalborg model, taking the practise at the different faculties and different programs into consideration. The formulation of the AAU PBL model has thereby raised internal awareness of these diversities, and initiated discussions of principles as well as practices, and has as such served as in internal energizer for change.

*Corresponding Author: Anette Kolmos. Tel.: +045-99408307
E-mail address: ak@plan.aau.dk

At the Faculty of Engineering and Science, this process of writing up the PBL principles went on parallel to a rather comprehensive curriculum restructuring in 2010, where the interrelationship between the subjects and project modules where to be considerably changed (Andersen et al., 2009). This was a considerable challenge for the study-boards representing the different programs and the implementation was, as any implementation, influenced by local contexts related to the different programs as well as different perceptions of why and how these changes should happen. Furthermore, reflections after the implementation process have brought strengths and weaknesses of the new PBL model out in the open, providing insight for further development. The question is: what can this implementation process tell about the drivers, challenges and prospects of reconstructing PBL curricula?

We will address this question by reporting a more comprehensive study on curriculum change at the Faculty of Engineering and Science focusing on how the study boards have perceived the process. The overall study has included experiences from top-management at the faculty level, middle management at school and study board level and last but not least from teachers and students. These experiences have been gathered by a mixed-methods approach, including individual as well as focus group interviews and surveys. This article draws upon previous reported interviews with top-management and presents the drivers and strategy for change (see Myrdahl et al., 2011). It also highlights new results from the analysis of the implementation and outcome at middle management level (Kolmos & Holgaard, 2012). This study reports the interviews which involved three school leaders and 11 study board directors. Each interview was semi-structured and lasted approximately one hour. The data were analysed thematically by categorising perceptions of the old as well as the new model and the challenges of implementing and revising the new model.

In the following section we will shortly present the context of the study, first by introducing the overall principles of the PBL philosophy behind the Aalborg model and then by presenting the elements in the old as well as the new model (section 1). After that, we describe the drivers for change, the challenges in the implementation phase, the actual outcomes of the re-construction process and the perspectives for further developments of the overall model (section 2). This leads to specific attention to the challenge of making comprehensive and aligned curricula that secures the interrelation between subjects and projects (section 3). Finally (section 4), we conclude this paper by discussing what the Aalborg case informs about the drivers, challenges and prospects of reconstructing PBL curricula.

2. The former and present Aalborg PBL model

The PBL philosophy embedded in the Aalborg model builds on constructivism as a learning philosophy and democratic values in terms of participant directed learning (cf. Kolmos, 1996) and contextual knowledge (cf. Jamison & Holgaard, 2008). In particular, the principles of the PBL model at Aalborg University follows the three dimensions of PBL learning stressed by Kolmos et al. (2009): i) Cognitive learning based on problems, projects, experiences and context, ii) Collaborative learning by teams and participant directed processes iii) Contents stressing inter-disciplinarity, exemplarity and the relation between theory and practice.

However, there are many ways to structure these elements, and in the following we will present the "old" Aalborg model, which have formed the basis for the structure of PBL curricula in more than 20 years at the Faculty of Engineering and Science, Aalborg University and the "new" reconstructed PBL model implemented in spring 2010.

2.1. The "old" Aalborg model

In the "old" Aalborg model illustrated in figure 1 (Kolmos et al., 2004), the so-called 'project unit' covered approximately 75% of the semester and consisted of a project covering 50% of the semester and so-called project unit courses amounting to 25% of the semester. The project unit courses were on topics aimed at being used and assessed during the project. The project unit resulted in a project report jointly authored by the students in the group. Finally, 25% were covered of the so-called general courses assessed in separate exams.

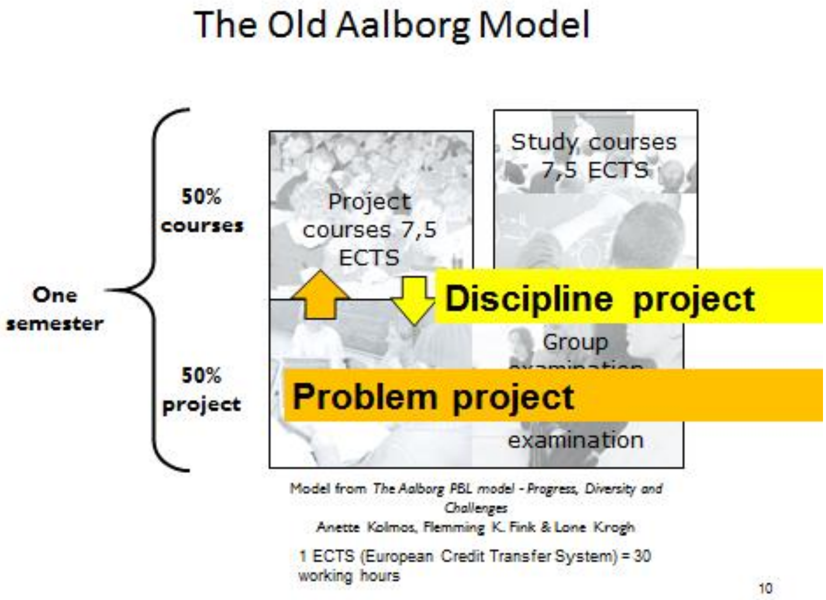

Figure 1. The old PBL model at the Faculty of Engineering and Science.

Typically, the phases of a project module were that a team of students (usually between five and eight), within the frame of a pre-defined project unit theme, formulated an initiating problem (sometimes based on a catalogued of project proposals). Then they moved to problem analysis and based on that, they formulated a narrower problem related within disciplinary boundaries. Taking the point of departure in this problem formulation and a methodological framework they solved this problem and assessed the proposed solution taking results of the problem analysis into consideration. This was reported in a written project report. In the project unit courses, the students were given lectures and worked with assignments which were in direct connection to the semester theme; and due to the close relation between the projects, these courses were assessed during the project exams. This was different to the general courses, where the learning outcomes gained not necessarily were applied directly in the projects in the same semester. The general courses were instead targeted towards more generic skills, to be developed over several semesters. Courses in the field of mathematics and physics were typical examples of such general courses. These courses were assessed separately, in either an oral or a written exam.

The individual project in the courses might be closely related to the project unit themes or, depending on the student's choice of problem, result in very different types of themes. In the case of rather narrow semester themes, the project learning outcomes could be directly related to one or more project unit courses. In such a case, the project's role was to further develop the skills obtained in the project unit courses to competences through addressing real life problems (i.e. a so-called discipline project). In cases, where the project theme were more openly defined (enhancing so-called innovation project), the project unit courses were developed in a more ad-hoc manner in order to address the challenges students were facing in their actual projects. To prepare project unit courses that could capture the diversity of the projects, a high number of small project-unit courses of 1-2 ECTS were developed.

2.2. The new Aalborg model

In the new PBL model, project unit courses are abolished, and thus the project unit as a concept does not exist any longer. In the new model, there is a new terminology: course modules and project modules (section 3.0 discusses the differences of these modules in more detail). The old project unit was limited to the project module, which constitutes 50% of the time. In addition, there are now three course modules of 5 ECTS, each with their own exam (see Figure 2). This new PBL model appears less complex than the earlier model, but the course modules are not necessarily supplementing the projects, although some may be.

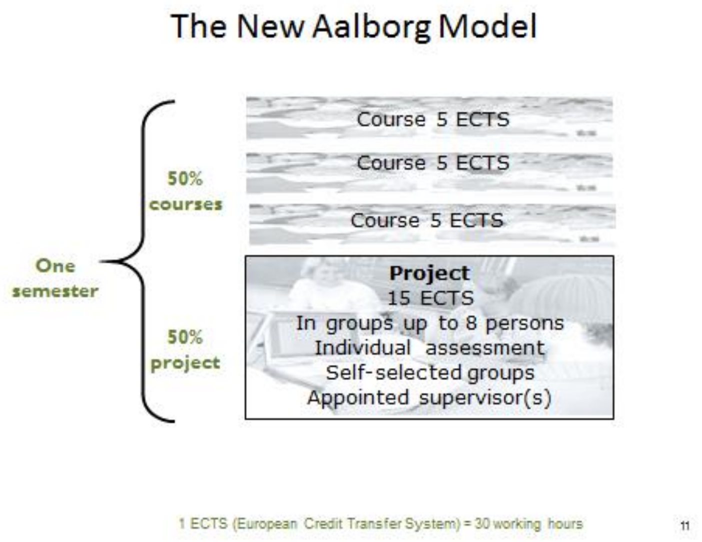

Figure 2. The new PBL model at the Faculty of Engineering and Science.

3. Evaluating the change process

The evaluation of the change process due to the reconstruction of the PBL model has included several components, an analysis of the drivers for change, the organizational challenges in the implementation phase, the pedagogical practice that is derived from the new PBL model as well as perspectives for further developments of the model. In the following section, an overview of the results, related to these focus points, is presented based on the more elaborated report by Kolmos and Holgaard (2012).

3.1. Drivers for change

Analysis of the interviews with top-management indicates that the changes in the Aalborg model were initiated as a response to the considerable changes in the external framework conditions for higher educations in Denmark. These conditions include a decrease in financial support and accreditation demands owing to the Bologna process. The internal reasons were to create a more flexible system for credit transfer and visions of more active learning methods in the larger courses. It also includes an opportunity to reduce the stress of both students and teachers due to the national accreditations process which resulted in that learning outcomes and the number of accredited ECTS in the Aalborg curriculum were adjusted to become similar to curricula requirements at other universities. Before the Aalborg students had worked "too much" for the same ECTS (Myrdahl et al., 2011).

The leaders of the study boards have followed much the same line of reasoning, but emphasized two main arguments for changing the curriculum. The first reason was that there were too many smaller courses and it was difficult to credit other types of courses earned outside the enrolled program. The second reason was related to the assessment of the project unit courses, which became problematic when the Danish government in 2007 banned group-based assessment. This meant that there was not any longer an opportunity to argue and discuss the project as a team and the discussion of the project phases was broken up into short sessions (Kolmos & Holgaard, 2010; Holgaard & Kolmos, 2009).

3.2. Challenges in the implementation phase

One of the biggest challenges in the implementation process was to re-design the project unit courses as well as general courses to fit the standard of having three courses of 5 ECTS each semester and at the same time re-select content for the courses to harmonise the norms for ECTS. This process has challenged existing understandings of what the students have to learn and what the core discipline is all about. Different re-selection strategies have been in play – merging different subjects, excluding specialised subject areas or moving areas of application to be considered in the projects – leaving the theoretical abstractions for the course modules.

A related challenge has been to group often diverse content into three 5 ECTS blocs. This has resulted in strange combinations of content in 5 ECTS modules, such as a course in Mathematics and English. The problem of such combinations is that the learning outcomes becomes so varied that it became hard to design only one assessment session intended for the course modules. Another problem arose in merging smaller subjects of 2 ECTS each into 5 ECTS module. Finally, due to economic concerns, some of the 5 ECTS modules were designed to embrace different however related programs.

Besides the new course structure, an overarching challenge was to cope with a relatively fast implementation of the new PBL model due to the economic situation and demands from accreditations authorities. At the same time demands for reconstructing the curricula to the Bologna qualification framework as well as a new national grade scale that stipulated the formulation of assessable learning outcome put pressure on the way that learning objectives had to be formulated. These change processes resulted in a demand for a thorough revision of study regulations – considering both the overall structure and detailed discussions of how formulation of learning objectives should be for each module. The study boards were simply overwhelmed by the workload. The other Danish universities were also required had to adapt to the Bologna process and the change of grade scale but they did not at the same time have to change their whole educational structure. Even so, the grade scale change in itself demanded considerable change (e.g. Brabrand & Dahl, 2009). The Aalborg Model, in addition, was implementing even greater changes.

The pace of the implementation also resulted in lack of involvement from pedagogical consultants, and many study-boards sensed that staff was not ready to respond to the new visions of more innovative pedagogical methods. Furthermore the time for clarifying the boundaries between what can and cannot be done was limited, and the interpretation of freedom to step outside the structures of the overall model differed considerably. Overall boundaries were presented, but there were no time to discuss the model in relation to the different conditions in the different study boards and even at program level.

3.3. Practice derived from the new model

The new PBL model has resulted in a variation of practices. One variation of the model is to have a project module of 20 ECTS and 2 course modules of 5 ECTS. There are also examples of project units of 5, 10, 15, 20, 25 or 30 ECTS, respectively; however it is rare that there are any deviations from the standard model in terms the 5 ECTS course module size. It is not in itself a weak point that it is possible to deviate from the model, as there may be pedagogical reasons for this - but not all staff and leaders have been aware of possibilities for deviation in the first iteration of implementation.

Furthermore, the simplicity of the model, combined with the vision of new and more innovative teaching and learning methods in the course modules, has resulted in a rather blurred picture of what is actually project-organised and what is not. This is not a problem if the modules are coordinated and planned carefully in relation to learning objectives together with students' progression and workload. However, there are examples of students who conduct several projects during one semester. Some are mini-projects in the course modules in addition to the project module. There are also examples of the opposite such as integrating lectures in the project module. The existence of such a diverse picture questions whether the new model provides room for a too unilateral curriculum.

In many ways, the need for coordination seems to be crucial to realise the intentions behind the new PBL model. The intention to have more course modules across programs has intensified the need for academic as well as administrative coordination. Furthermore, the increased number of exams, which has been the case for most programs, together with the tendency to combine rather divers learning outcomes in one and the same module, has increased the need for coordination in designing the exams.

Last but not least, a very important result from the analysis, which can be traced all back to the re-structuring of the PBL model, is that the new PBL model makes room for the alignment and synergy between course and project modules. In fact, the analysis shows that educational leaders have experienced that the re-structuring process has led to an increased separation between the courses and the project; and as mentioned earlier the distinction between course and project modules is at the same time becoming increasingly blurred. Furthermore, there were cases where confusion between courses and projects exist, whereby issues on what is to be examined in the project and what is to be examined in the course were raised. In other words, there may be overlap in the exams due to unclear learning objectives. In sum, there seems to be a lack of clarity of how to interrelate course and project modules. In programs with strong cultural carriers of the PBL culture among the staff, the practise does not seem to differ a lot from the previous model and there is clarity of what is the purpose of courses, projects, and exams. However, one may argue that this might be due to the fact that not much has actually changed. However, in programs without strong cultural carriers (for instance with a lot of new staff not knowing the old model), such common lack of clarity in the new PBL model certainly have an effect.

3.4. Summing up on future challenges

The restructuring of the PBL model at Aalborg University points to a number of challenges and indicate clearly the complexity in changing a curriculum structure – and this does not only count for a PBL curriculum, but for curriculum development in general.

All interviewees indicated that a core element in a successful change is training the academic staff. This explains that even experienced staff needs pedagogical training to cope with considerable curricula change especially when the management state a vision of new and more innovative teaching and learning methods. In such cases, training to support the diversity in teaching as well as to allign the use of learning techniques is highly needed. In addition, upgrading teachers in handling various forms of assessment methods including formative and summative assessment is crucial. What happened in practice was the that the academic staff, being used to run projects, in abundance have made use of mini-projects. But this has caused problems in the system, as the students feel overwhelmed by having to deal with so many projects – ironically too much PBL.

But the biggest challenge is in the interaction between course modules and projects where previously there was a more explicit relation in terms of the project unit courses. The challenges of the old model were many, including adaptation of project unit courses to the project, new examination rules prohibiting group exam, students not prioritising courses without separate exams and also a number of administrative matters due to the ad-hoc nature of the project unit courses. The interviews showed however, paradoxically, that although the project unit courses were seen as a one of the biggest challenges in the old model, it is also highlighted as the primary strength of the model.

4. Interlinking course and project modules

In the following we take our point of departure in the new PBL model when describing and discussing four possible models for interlinking course and project modules. We have chosen to introduce case-modules in the models and re-introduce project unit courses, to emphasise the distinctions and the variety of different types of modules. We will distinguish between three types of modules: A *course module* is a type of course that is designed to enhance knowledge and generic methodological skills. A *case module* is a type of course that presents students to pre-defined problems, which can be found in a real life situation, and facilitate that the students come up with correct solutions. In the *project modules*, the students themselves define an open problem and develop solutions based on a thematic framework. In fact, there may be a continuum of types, but these three types of modules we believe can provide a starting point for a discussion of the balancing of the various teaching methods in relation to different learning outcomes.

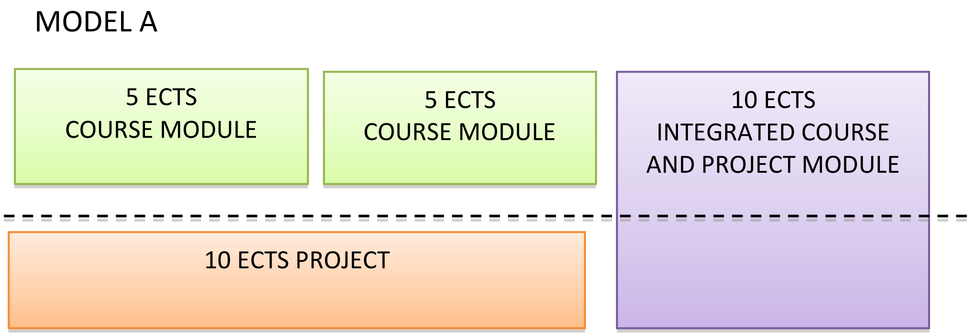

Figure 3. Model A introducing a 10 ECTS mini-project integrated with a course module.

MODEL A (figure 3) shows how two courses and a project module are integrated. This model has the aim that the theory and methodology learned in the course module is supplemented with a mini-project, were students are to define a problem and use the course material to solve this problem.

MODEL B (figure 4) illustrates a structure where a course combines an emphasis on theory and skills with a case to exemplify the use of the material in a real-life context. Students typically work towards the solutions of relatively closed and pre-defined problem formulations.

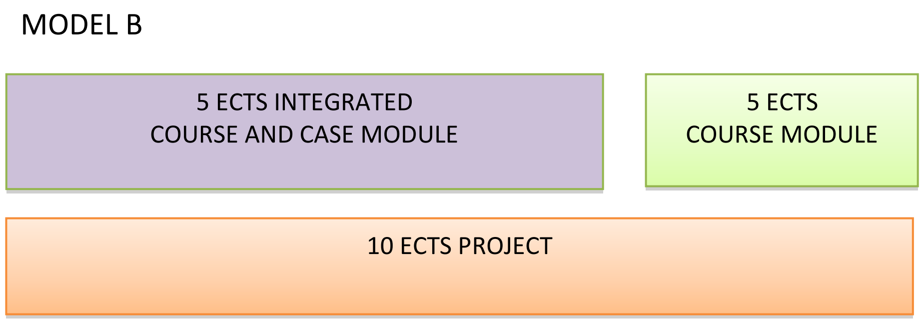

Figure 4. Model B introducing a 10 ECTS combined course and case module.

MODEL C (figure 5): In this model, there is an overlap between two of the course modules and the project. In practice this can be obtained by defining parts of the learning objectives of the courses in direct relation to the project theme. The advantage of this is that the project and courses are better connected, but on the other hand, this might limit the student's possibilities to work with open problems. This has some resemblance with the project unit course in the old model.

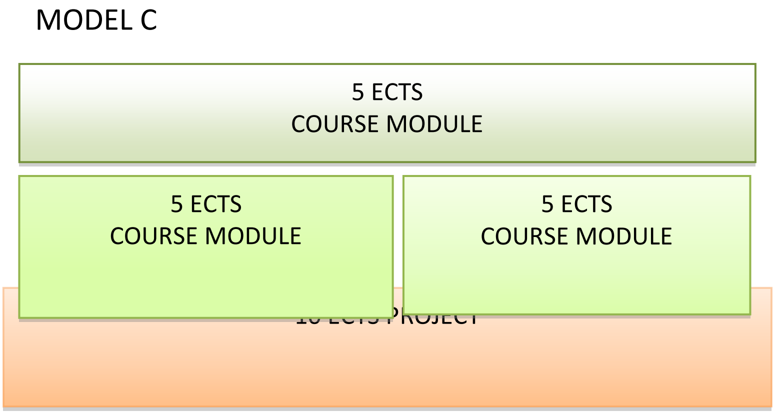

Figure 5. Model C introducing two 5 ECTS courses which have elements of a project unit course.

Model D (figure 6) combines the old and the new AAU PBL model by re-introducing a project unit course, which is examined as a part of the project. For disciplinary projects, this course could be designed directly to supporting the project. For more innovative projects (see section 1.1 for further discussion of disciplinary and innovation projects), this course could in fact be an elective course to take advantage of the fixed 5 ECTS modules. The students are also given the possibility to pick a course from another program, if it is suitable for the project. In these cases however, this challenges the examiners of the project to move into other areas or to carefully select an appropriate external examiner, if the project unit course is to be examined together with the project.

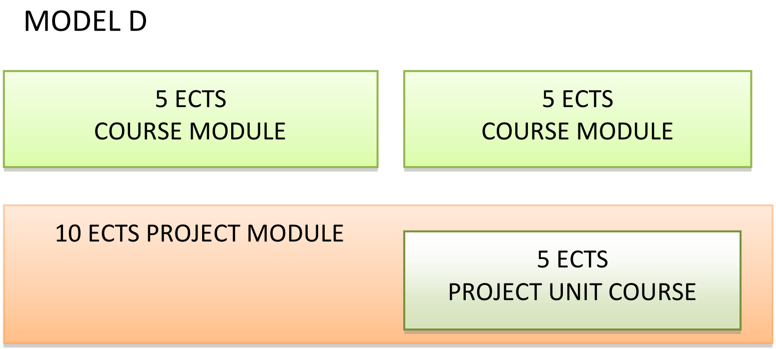

Figure 6. Model D re-introducing a 5 ECTS project unit course.

There are certainly more opportunities than those outlined above, but no matter which model is chosen, it is important that the interplay of different types of modules are explicitly addressed and argued. Furthermore, a model is not enough to realise this interplay. Coordination of teaching and learning (and examination) methods among the modules is to be considered as crucial.

5. Conclusions

In this paper, we have reported and discussed the intentions and experience from the restructuring process of the Aalborg PBL model. Our main question behind this study was: what can this implementation process tell about the drivers, challenges and prospects of reconstructing PBL curricula?

As drivers for change we identified a decrease in financial support and at the same time harmonisation of education across institutions and international borders. These challenges related to the economic crises, harmonisation among European countries and at the same time the increased globalisation of engineering education institutions which is putting pressure on even the most ambitious pedagogical models, underlined the fact that no pedagogical model should be stable.

The challenges we have documented in this study give rise to the following conclusions. First of all, the pace of the implementation process is crucial, but also the large number of changes that happened simultaneously. Innovations of course structure and content have to happen at a certain pace in order to reflect the state of art in society, but the pace have to make room for i) pedagogical support and training, ii) a strong coordination to assure an aligned curricula iii) appropriation of the model to local contexts iv) a strong awareness of the difference in the pedagogical methods and the interplay between them. It is tempting, and maybe especially for engineers, to rush into the implementation process to solve the problems at hand – and build the bridge as we walk on it. However, the first implementation should not exhaust the organisation in a way that fosters resistance towards continual innovations.

In this paper, we identified the weakness of the new Aalborg PBL model whereby the interrelation between course and project modules are not explicitly emphasized, intensifying the ambiguous distinction between courses and project. However, the old model was not without problems either. For instance, students did not always take the project units courses seriously when these components were not used in the projects and usually not formally assessed during the project exam. Taking this as our point of departure we have exemplified, how awareness of the difference in pedagogical methods can be used to develop different PBL models; in this case by distinguishing between projects, course and case modules, and combining them in different ways to emphasise integration and interrelation between modules. It is our hope that these models can serve as inspiration for others constructing or reconstructing PBL curricula. In this way, the new Aalborg PBL model which formally was introduced due to external demands, can in fact be a model that has enough flexibility to continuously adapt and be in the forefront of development. In this way, model becomes models. It may also be a model that due to its flexibility can give the academic staff in different programs the tools to precisely design a structure that is well suited for the learning objectives and goal of that particular program and therefore a way to keep updating, changing and adjusting the Aalborg PBL model(s).

References

Andersen, L; Andersen, L.D; Hornemann, B.C; Johanssen, L.Ø; Lorentsen, A. & Steinø, N. (2009). *Anbefalinger til organisering af uddannelserne* (Recommendations for reorganisation of educations), The Faculties of Engineering, Science and Helath. Danish version can be obtained from: http://vbn.aau.dk/da/publications/anbefalinger-til-organisering-af-uddannelserne(fc1a4b7b-ad64-4a60-adbc-4b405a53c7ec).html.

Barge, S. (2010). *Principles of problem and project based learning: The Aalborg model*. Prepared for Aalborg University, September 2010. Can be obtained from: http://www.en.aau.dk/About+Aalborg+University/The+Aalborg+model+for+problem+based+learning+%28PBL%29/.

Brabrand, C. & Dahl, B. (2009). Using the SOLO-Taxonomy to Analyze Competence Progression of University Science Curricula. *Higher Education*, 58(4), pp. 531-549.

De Graaff, E. & Kolmos, A. (2007). *Management of Change: Implementation of Problem-Based and Project-Based Learning in Engineering.* Sense Publishers.

Holgaard, J.E. & Kolmos, A. (2009). Group or Individual Assessment in Engineering, Science and Health Education: Strengths and Weaknesses. In (eds.) X. Du ; E. de Graaff & A. Kolmos (pp. 57-69), *Research on PBL Practice in Engineering Education*. Sense Publishers.

Jamison, A. & Holgaard, J.E. (2008). *The cultural appropriation of contextual knowledge*. Presented at the Engineering Education in Engineering Education (EESD) conference in Graz, Austria, 22-24 August.

Kolmos, A.; Fink, F.K. & Krogh, L. (eds.) (2004). *The Aalborg model: Progress, diversity and challenges*. Aalborg University Press.

Kolmos, A.; de Graaff, E. & Du, X. (2009). Diversity of PBL – PBL learning principels and models. In (eds.) X. Du, E. de Graaff & A. Kolmos, *Research on PBL practise on Engineering education*. Sense Publishers.

Kolmos, A. & Holgaard, J.E. (2012). *Evaluering af ændringerne i PBL modellen på TEKNAT AAU***.** Danish version ca be obtained from: http://vbn.aau.dk/files/70042384/Evaluering_af_ny_PBL_model.pdf.

Kolmos, A. & Holgaard, J.E. (2010). Responses to Problem Based and Project Organised Learning from Industry. *International Journal of Engineering Education*, 26(3), 573-583.

Myrdal, C.G.; Kolmos, A. & Holgaard, J.E. (2011). The new Aalborg PBL model: first part of the story from a management perspective. In (eds.) J. Davies; E. de Graaff & A. Kolmos (pp. 726-738), *PBL across the disciplines: Research into best practice*. Aalborg University Press.

Neville, A.J. & Norman, G.R. (2007). PBL in the Undergraduate MD Program at McMaster University: Three Iterations in Three Decades. *Academic Medicine*, 82(4), 370-374.

Savin-Baden, M. (2003). *Facilitation problem-based learning.* Society for Research into Higher Education and Open University Press.

Constructing a Professional Development framework for PBL at a Middle East HEI

Oonagh McGirr*

Acting Manager, Teaching and Learning, Bahrain Polytechnic, Isa Town , PO Box 33349, Kingdom of Bahrain

Abstract

This research paper reports on the trajectory of a recently established HEI in the Middle East and the challenges faced in embedding PBL as the underpinning methodological approach for Teaching and Learning. This paper documents the implementation and subsequent review of teacher training and development activity at a tertiary education provider specialising in student centred learning (SCL). The paper seeks to draw from the research evidence base to propose a way forward in establishing a professional development (PD) framework which supports the continuing training and upskilling of teachers at Bahrain Polytechnic. The paper documents the chronology of such work in response to institutional research, operational challenges and ongoing review. The paper reports on the proposed adoption of a transitional professional development approach to provide sustainable PD in support of the facilitation of student centred learning at Bahrain Polytechnic, seeking to document the process thus far, report on the updated intra-institutional research findings and the subsequent attempt to construct a framework to support the implementation of a sustainable training and development offering for academic staff.

Keywords: Professional Development, PBL, Quality Development, Teaching and Learning, Student Centred Learning

1. Introduction

Bahrain Polytechnic was established in 2008, by the Bahrain Government to address the need for a skilled Bahraini labour force and to support economic growth and diversification. Five years on, the Polytechnic may be considered to have moved out of set up and into consolidation phase. During this time, the Polytechnic has established itself as an important HEI in the Kingdom of Bahrain, with a current student cohort of 1800 who attend 23 applied undergraduate and foundation courses across three faculties and six schools. The institution offers a range of applied courses to bachelor's level, including Business, Engineering, ICT, Visual Design, Logistics and Web Media. The first cohort of graduates is anticipated for June 2013.

2. Background

In terms of **t**eaching and learning, the Polytechnic has, since its inception, marketed itself as a PBL institution, with a focus on producing work ready graduates in response to the 2030 Economic Vision for Development (and growth) in the island kingdom. In order to achieve this, there is an imperative to populate the employment market with a skilled local labour force. The current vision and mission, revised and approved in 2013 speaks of the institution becoming a *"world class provider of applied higher education, producing* professional and enterprising *graduates with the 21st Century skills necessary for the needs of the community locally, regionally and internationally delivered in co-operation with our society and the wider educational community*."

As Coutts, Huijser and Almulla (2011) outlined, the Polytechnic initially engaged with a project based approach to developing a PBL focused methodology for the facilitation and delivery of a portfolio of applied courses. While the set up and establishment of a PBL-led HEI proposed a huge challenge, it was also in many ways seen as having significant advantages; effectively providing a carte blanche to create new PBL applied curricula for all courses through collaborative design, and the freedom to innovate. A key challenge in achieving this objective clearly centered on creating baseline knowledge and experience of PBL amongst faculty, more so given the nature of what might be defined as "teacher capital". Drawing on Bordieu's (1973) conceptualization that students come with a complex set of knowledge, experiences and dispositions, it may be posited that the same is true of teaching staff; they may have diverse and eclectic backgrounds with a range of expertise and experience, rooted in individual and institutional pedagogies and practice. The challenge then at the outset was for the Polytechnic to provide an introductory level of training and development in PBL, which would allow tutors to engage in delivery and then to grow such work into a fully fledged form of continuing professional development (CPD), support and training which would provide a sustainable and manageable portfolio for staff to access.

* Oonagh McGirr. Tel.: +973 39057598
E-mail address: oonagh.mcgirr@polytechnic.bh

2.1. Initial Set up

Five years on, it is useful and pertinent to review progress on the original intention of providing training which would support the integrated approach originally espoused; where space for discussion would enable staff to debate the issues arising around PBL and its implementation, and allow for resolutions to be found. Clearly, the success of such an approach would be contingent upon the provision of appropriate and timely support and training for staff. The original focus for teacher development was to provide tutors with front-loaded training that would familiarize them with the pedagogical context of Employability driven curricula supported by a SCL methodological approach to teaching and learning.

2.2. Implementation activity

As part of the start-up activity, the Polytechnic worked with PBL experts to deliver a range of workshops for staff, and initiated a series of PBL pilots, which would form the basis of a phased programme roll-out across all Polytechnic faculties, frameworked within a five year plan. This plan was later reviewed and amended to create a more integrated working plan which responded to the multiple perceptions of PBL amongst teaching staff. The revised version advocated continuous support from PBL experts into courses, under the guidance of a newly appointed Steering Committee. The key strand of work comprised of a front loaded training programme led by experts in the field of PBL and delivered to the first cohort of teaching staff in July and August 2010. Subsequent to this, the Steering Committee assumed the role of monitoring, consulting on and providing directives to ensure the embedding of PBL methodology was facilitated across the institution; part of the Committee's remit was to advise on support for teachers tasked with leading on PBL at course and programme level. The Committee worked with the Professional Development Centre at the Polytechnic - an informal PD planner was created and populated with workshops, seminars and one to one training sessions which focused on the salient topics raised in discussion with tutors Human Resources (HR) and Staff Development Specialists, who then worked to organise training for staff and signpost them to PBL and Curriculum Specialists for further help and guidance. This arrangement developed organically, was loose in framework, and at times reactive, working to provide training often after consultation and equally at times through forward planning.

2.3. *Post implementation activity.*

Following the start-up planning and piloting activity, the Polytechnic committed to supporting all staff by inducting them into the Polytechnic focus on SCL and PBL; initial training centered on working with all incoming staff to provide them with an introduction to teaching and learning through Certificate in Tertiary Teaching and Learning (CTTL). The CTTL programme comprises of three courses – Introduction to Teaching, The Adult Learner and Technology in Teaching – the certificate is modelled on an existing level 5 programme and is designed to give tutors an introduction to the fundamental principles and practices of teaching and learning for third level instruction. While there was some debate and movement of position in terms of who may be required to complete the course, it was ultimately decided that all staff engaged in teaching and learning activity should be required to do so as a mandatory activity. It was felt that this would help to create a community of practice (Wenger 1997) with common values and understanding of PBL, work to counter the more traditional notions of so called "chalk and talk" or more didactic teaching approaches and enable managers and faculty to experience and understand the Polytechnic concept of PBL as an integrated flexible approach to applied instruction. The mandatory requirement was deemed necessary as many of the staff came from a variety of backgrounds, and had been selected for their industry experience – to enable current knowledge and skills transfer into courses. The CTTL was seen as a vehicle for the start of a discourse around teaching and learning at the Polytechnic.

Alongside the intensive CTTL course, delivered as a follow-on to induction training and prior to the commencement of teaching, tutors were also supported with the presence of Curriculum Specialists (3 FTE) to work with them on an ongoing basis, specifically in the areas of assessment and quality management. It was hoped that this two-pronged approach would assist staff in making the paradigm shift from the teacher-centered model to a specific variant of student centered learning (SCL).The crux of the teacher training strategy adopted was one of creating "events", managed and delivered by Teaching and Learning specialists, who in turn worked with PBL staff – which in PD terms meant training and development activities on a regular basis, designed to support and guide staff in the acquisition of the knowledge and skills needed to engage with a PBL delivery model. It was anticipated that with the combination of bottom- up support and top-down direction that staff would migrate naturally, though experience and practice to Problem Based pedagogy.

3.0. Research and review.

In 2010 (Coutts, Huijser and Almulla) documented the findings of institutionally based research, which sought to review the outcomes of the initial efforts to embed a pedagogic culture of SCL, and specifically PBL. This first small scale qualitative research conducted in 2011 aimed to capture and understand the perceptions and interpretations and engagement of staff with

PBL. Through a series of interviews, focus groups with teaching staff and managers, and analysis of pilot courses, the researchers presented a list of finding and recommendations.

The findings provided key emerging themes amongst staff, primarily around anxiety in undertaking what they perceived to be a new teaching approach, and a key concern around the provision of professional development to support staff. In the Spring of 2012, following the initial research and review, a further small scale research project was undertaken by the Quality Measurement and Analysis and Planning department (QMAP) and the newly appointed Acting Manager for Teaching and Learning at the Polytechnic.

3.1. Method

A qualitative approach was taken as the researchers wished to gain further insight into the perceptions and interpretations of staff regarding PBL and their engagement with it. The three main sources of data which informed the research were a questionnaire disseminated to all staff in May 2011, open focus groups at the Bahrain Polytechnic Third Teaching and Learning Symposium held in July 2012 and a range of documentation held by the Polytechnic for audit and evaluation purposes .The objective of the research was to build upon the previous research conducted in 2011 (op cit Coutts, Huijser and Almulla).

3.1.2. Documentation

A number of documents helped to inform the review and development of PD: The Annual Review Documents for CTTL; evaluation questionnaires completed by staff who had attended the additional suite of PD events across the academic year, and unsolicited staff generated communications about the CTTL and other PD work, all provided an insight into the aspects of the training; which areas might benefit from enhancement, and which areas of training and development were deemed to be useful by the participants.

3.1.3. Questionnaires

A questionnaire (Appendix I) was devised and disseminated by the Quality Measurement and Analysis Department of the Polytechnic in May 2011, The document was sent out electronically and reminders were sent at weekly intervals to all staff until the close of sampling period (May- June 2012). Completed questionnaires were returned to the QMAP for analysis. QMAP worked closely with the Teaching and Learning Unit (TLU) to identify key themes emerging from the responses; content analysis was used to identify specific themes.

3.1.4. Focus Group

The focus group participants attended the Symposium workshop sessions "*Don't Dispel PBL*" (McGirr, 2012), at which the initial findings of the QMAP survey were presented. The participants worked in small discussion groups tasked with providing responses to the three questions previously presented in the questionnaire, giving verbal feedback which was recorded by a researcher. Participants were encouraged to expand upon their responses, and to express their views without prejudice.

3.2. Results and Findings

Of the 160 questionnaires sent out to staff in May 2012, 53 responses were received by the deadline and subsequently analyzed; the response rate was 33 %. The Symposium presentation and focus group was attended by 23 members of staff, 6 of whom had completed the questionnaire previously – indicating that a total of 68 staff responses contributed to the final feedback The evaluation forms, referred to previously in 3.1.2, provided subsequent to the individual development and training sessions in-house by teaching and learning specialists had an 80% return rate, with a total of 87 completed.

3.2.1. Responses

The range of survey responses given demonstrated an inconsistent understanding of PBL whilst simultaneously highlighting significantly higher levels of understanding around specific aspects of PBL. The focus group responses reiterated and corroborated the findings of the survey. Further analysis of the data, and ranking of the frequency of responses indicated that the key concerns raised were:

- There is confusion regarding the institutional articulation of PBL
- There is a perception that the Polytechnic has a partial commitment to PBL
- There is a desire amongst staff for more robust and higher level teacher training for PBL.
- There is a perceived lack of consistent and coherent ongoing training for staff
- There is no single or common understanding of PBL; knowledge is patchy and varies from faculty to faculty

- Staff perceive that there is no clear understanding on the part of the students and very mixed expectations. Student capital is varied and variable

3.2.2. Emerging themes

In contrast to the findings of the research conducted in 2011, the work of 2012 indicated that staff understandings of PBL were more disparate, less positive amongst the respondents, with some individuals indicating a clearer perception of some of the specific aspects of PBL, while others noted that they were either unsure or unconvinced of the value of PBL. This would suggest that despite a sustained programme of staff development, the knowledge base regarding PBL had diminished compared with the previous research findings presented 12 months earlier. Most staff articulated a commitment to this methodological approach, whilst the more detailed responses showed that tutors from certain faculties expressed a stronger commitment to the approach and felt more comfortable about it. Furthermore, a small number of respondents perceived this as a lack of success, institutionally, citing inconsistent training as a key factor. Further inspection indicated that while training was offered, awareness was low amongst some staff, and this may be a factor in non-attendance. The comments provided highlighted that many staff did not recall receiving any consistent communications regarding PD, and therefore found planning difficult.

The review of documentation drew out similar themes – the annual review documentation for CTTL and the completed evaluation questionnaires underlined the need for more subject specific and practical training in PBL, whilst also questioning the appropriacy of the level of the course (level 5 NQF). Many staff expressed a need for further higher level training (PG level), and cited the need for internationally accredited certification.

3.2.3. Recommendations

While operational recommendations can be made in response to the emerging themes and findings of the two research projects, it is worthwhile considering how the Polytechnic may wish to framework Professional Development going forward. Recent organisational changes have a part to play, and should not be eschewed in favour of resorting to a simplified model (the Polytechnic engaged in an organisational review in 2012, resulting in some changes to department structure)– rather, in working with those changes, the newly established Teaching and Learning Unit may seek to establish an holistic and sustainable model of practice which brings together the Polytechnic community – creating a broader community of practice with variable but consistent discourses around our educational mission. In a subsequent institutional report on the research, the following recommendations were outlined as key:

- Develop / Review and articulate a clear institutional Strategy for PBL at Bahrain Polytechnic
- Develop/ Review a Resource Plan to ensure all faculties have the appropriate equipment, staffing and materials
- Develop and implement ongoing and robust programs of staff training, with a two tier approach – introductory and advanced training
- Ensure awareness of PBL for all incoming cohorts of students
- Develop an institutional awareness and understanding of Scholarship around PBL Teaching and Learning through the promotion and support of research

4.0. Developing a Professional Development framework

4.1. Discussion

While the recommendations present us with a base from which to depart, there is a need for us to be more ambitious in our planning and as the phase of development demands, and to aspire to *consolidate* the work we have already undertaken. In order to do this, we need to consider the variable factors and forces at work. In reviewing the staff responses to the questionnaires, and comparing them to the evaluation forms completed over a longer period of time, it became evident that one of the key factors impacting on institutional conceptualization and adoption of any methodological approach is the natural attrition of staff. Of the original staff who received initial training and engaged in pilots in 2010, 55% remain. Despite the continuing staff training and development, it is clear that it has not kept pace with the natural levels of succession occurring – and in turn this has impacted on staff perceptions of institutional knowledge and expertise. Staff mobility and turnover are important influencing factors, notably the natural attrition rate which influences how much of our corporate (professional) knowledge we retain. With an average turnover of 10% of staff annually, the Polytechnic needs also to look at how it can provide initial training for incoming staff, whilst building upon the knowledge base of others. We seek not to diminish our broader base of pedagogy, but to understand our practices more, and to consolidate good practice. Furthermore, as Chalmers et al (2008) note, participant choices regarding development are directly related to employment prospects – this has bearing on the type and nature of training selected and any commitment to it. Inherent in any offering, we must strive to embed dual motivations, ensuring intrinsic and extrinsic value.

A further consideration is the notion of commitment. Upon inspection of the documentation, it became clear that the take up of additional PD by staff once they had completed the taught components of the CTTL was inconsistent; some staff committed regularly to monthly or bi-monthly PD, while others did not complete any further training subsequent to the CTTL training. Effectively, this means that some staff members could have completed at least two academic cycles without any additional training or support – and while it should be recognised that this may only be true of a small number of staff, it is nevertheless a concern, which has broader and far more serious implications for the quality of teaching and learning. This indicates that aside from reviewing the current offering of PD content, we need to consider how we manage attendance, and what type of protocols and policies we put in place to foment better achievement and completion rates amongst participants.

A strategic approach to the construction of a workable and sustainable framework requires consideration of the factors at play, extra and intra institutionally. With the organizational restructure of the Polytechnic, and in response to the commendations and recommendations of the NQAAET Audit Report in 2011, the Academic Directorate has recognised the importance of a dedicated Teaching and Learning Unit (established July 2012), thus consolidating the work completed by the teaching and learning specialists in the set-up phase and beyond. The unit has been allocated a quota of up to six FTE staff by the end of the next 5 year planning cycle; this augurs well for the future and demonstrates the commitment to support and training of academic staff.

Similarly, the Polytechnic, as part of its reorganization (April 2012) has set up a Professional Development Advisory Committee to monitor, inform, disseminate and approve applications for PD from both academic and allied staff. Since its inception, the Committee has completed a significant workload – receiving and approving 400 plus applications, with 75 per cent of those emanating from academic staff. The work is owned by the HR department, which in turn works to establish and manage policies for professional development, linked to an annual (reflective) review process.

If the goal of CPD at the Polytechnic is to recognise the need for the shift from the traditional / chalk and talk / didactic model to the generically named student centred model, then we do well to ponder the evidence from recent reviews carried out by Stes et al (2011), and Prosser and Trigwell (2007), whose investigations into teacher development activities give us food for thought. Research shows that PD programmes had, over a 30 year period in the UK, effected marked changes in teacher conceptual perceptions, particularly in guiding staff to student centred pedagogies; this supports the move to establish a core suite of PD – both introductory and advanced for all incoming staff to the Polytechnic. Postareff's follow up study (2008) confirms not only the positive impact on staff of PD, but also the nature of it, reporting positive changes on practice by teachers who had participated in *accredited* training (comparing favourably with and in contrast to the control group who had not completed any training).

The Recent HEA review of the impact of teaching development programmes in higher education (2012) identified *duration* as a key to successful teacher development. Differentiating between the impact of long term training in comparison to shorter interventions – which in some cases may affect teachers' perceptions negatively and lead to a diminution in self efficacy - evidence suggests that front loaded and intensive programmes, while valuable have little long term impact. Indeed, for PD to be valuable, it needs to engage the individual over a period of time. Empirical feedback institutionally further supports this – staff have clearly indicated that without accreditation, qualifications, while interesting, may have little value – and not least in an educational setting where expats make up the bulk of the teaching staff; many of whom are mobile. Any development activity then should be: incremental, long term, accredited and portable in order for it to have intrinsic and extrinsic value for staff.

The proposal is to engage with a *transitional quality development model*: which recognises the paradigm shift required of staff, builds capacity from work already achieved through the delivery of long term PD and engages staff and the institution in a reflective planning activity with tangible outcomes overseen by the HR department.

D'Andrea and Gosling (2005) propose an integrated model for professional enhancement which synthesises Teaching and Learning with Quality Assurance by addressing the tensions between the two prevailing forces (QMAP and TLU), seeking to create dialogue between managers and teachers, and ultimately address the internal and external policies and procedures regulating any HEI. If the QMAP informs the requirements of standards and indicators, mandated by external regulators while TLU seeks to benchmark and enhance practice to meet internal imperatives, it is the PD offering which is crucial to the successful convergence of these, and may be viewed as a powerful vehicle. Appropriate, timely and effective PD brings knowledge and expertise to the organisation, and greater self efficacy to the PD participant, all of which inform the teaching, and notably learning of the HEI. As D'Andrea and Gosling (op cit) underline, any ensuing debate facilitated through development activity enriches the concepts of teaching and learning. In advocating a transitional model (Kennedy, 2012) we recognise that such a model is flexible enough to tolerate underlying and competing agendas (Quality requirements, TLU objectives and Management directives).

In essence, distilling the discussion into key indicators is helpful in progressing towards the construction of a framework for PD. In developing a structure using the following precepts, we may meet the HEI requirements for quality assurance and facilitate the support and development of staff, and in doing so work to meet the institutional vision and mission. In other words, if our framework supports the specific and individual training needs of staff from the bottom up, we have a greater opportunity to ensure our staff members are engaged with the discourse of individual and institutional practice.

PD framework must be		How
Aligned	With the vision and mission of the HEI	Selecting / Providing PD which speaks to PBL and SCL
Valuable	For the Individual and Institution	Accredited Long term Mapped to Professional body competence and awards
Sustainable	In terms of cost and provision	Draw on internal expertise first Promote scholarship Seek external expertise incrementally over time
Triangulated	To respond to policy (QMIP), external drivers (NQQAET) and imperative for best practice in teaching and learning.	Embed as part of the staff performance review process Establish a reflective developmental (not punitive) process

Figure 1. Precepts for a PD framework

5 What next?

The Polytechnic, in establishing precepts for the development of a consolidated PD framework (moving away from the set up model which was looser, less defined and more organic in nature), is committed to engaging in a discourse around learning and teaching, which in itself is characteristic of the phenomenon identified by D'Andrea and Gosling, (2005) and Stes *et al* (2010), and deemed to be one of the remarkable features of the HEI sector development during the past decade by Parsons et al (2012). Practical aspects of the work going forward should align with modelled best practice and sustainability. If we are able to achieve the construction and implementation of a regulated and informed framework, then we can work towards establishing our own independent Polytechnic pedagogy, which may be an institutionally and regionally contextualized version of PBL / SCL.

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References

Bahrain Economic Development Board (2011). *Economic Vision 2030*. Retrieved 20 February, 2013 from http://www.bahrainedb.com/economic-vision.aspx

Bahrain Polytechnic (2013) *Vision and Mission.* Retrieved 20 February, 2013 from /http://www.polytechnic.bh/vision-and-mission

Barrett, T., & Moore, S. (2011). An Introduction to Problem-based Learning. In Barrett, T. & Moore S. (Eds.). *New Approaches to Problem-based Learning: Revitalising Your Practice in Higher Education* (pp. 3-17). New York: Routledge.

Bordieu, P., *Outline of A Theory Of Practice* (1973). Cambridge; Cambridge University Press.

Bong, S. (2002). Foreword. In Wee, K. N. L. & Kek, Y. C. M. *Authentic Problem-based* Learning: Rewriting Business Education (pp. ix-x). Singapore: Prentice Hall.

Coutts, C; Huijser, H and Almulla, H (2011). *A Project Management Approach to Sustainable Curriculum Design Implementation at Bahrain Polytechnic.* Bahrain: Bahrain Polytechnic.

Chalmers, D., Lee, K. and Walker, B. (2008) *International and national indicators and outcomes of quality teaching and learning currently in use.* Sydney, NSW: Australian Department of Education Employment and Workplace Relations.

D'Andrea V.-M. and Gosling, D. (2005) *Improving Teaching and Learning in Higher Education: a whole institution approach*. London: McGraw Hill.

Kennedy, A. (2005) Models of Continuing Professional Development: A framework for Analysis. *Journal of In-service Education, 31,(2,), 235-250.*

McGirr, O. *Don't Dispel PBL* . The Third Annual And Learning Teaching Syposium, Bahrain Polytechnic. July 8 – 12, 2012.

Parsons, D; Hill;I;Hollan, J and Wills, D.(2012) *Impact of Teaching Development Programmes on Higher Education*.York: The
Higher Education Academy.

Postareff, L. (2007) *Teaching in Higher Education from Content-focused to Learning focused Approaches to Teaching*. Research Report 214. Helsinki: University of Helsinki, Department of Education.

Postareff, L., Lindblom-Ylänne, S. and Nevgi, A. (2007) The effect of pedagogical training on teaching in higher education. *Teaching and Teacher Education.* 23 (5), 557-571.

Postareff, L., Lindblom-Ylänne, S. and Nevgi, A. (2008) A follow-up study of the effect of pedagogical training on teaching in higher education. *Higher Education: The International Journal of Higher Education and Educational Planning.* 56 (1), 29-43.
Prosser, M. and Trigwell, K. (1998) *Understanding Learning and Teaching: The Experience in Higher Education.* Milton Keynes: Open University Press.
Stes, A., Clement, M. and Van Petegem, P. (2007) The Effectiveness of a Faculty Training Programme: Long-term and institutional impact. *International Journal for Academic Development.* 12 (2), 99-109.
Stes, A., Min-Leliveld, M., Gijbels, D. and Van Petegem, P. (2010a) The impact of instructional development in higher education: The state-of-the-art of the research. *Educational Research Review*. 5 (1), 25-49.
Stes, A., Coertjens, L. and Van Petegem, P. (2010b) Instructional development for teachers in higher education: impact on teaching approach. *Higher Education.*60 (2), 187-204.
Wenger, E. (1998) *Communities of Practice*. Cambridge: Cambridge University Press

Appendix One

Bahrain Polytechnic Staff Questionnaire May June 2012

Please answer the following questions as fully as possible.

Q1: How would you define PBL in relation to the Polytechnic?

Q2: In your opinion, what are the challenges of implementing PBL in your course / programme?

Q3: In your opinion, what are the challenges of PBL in the Polytechnic context?

Training of Facilitators in Problem-Based Learning: A Malaysian Experience

Hussain Othman[a*], Berhannuddin M. Salleh[b], Wahid Razzaly[c], Abdullah Sulaiman[d], Nor Aziah Abdul Manaf[e], Zuaini Ishak[f], Sopia Md Yassin[g], Majid Konting[h]

[a,b,c,d]*University Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, Malaysia*
[e, f]*Northern University of Malaysia, Sintok, Kedah, Malaysia*
[g]*Sultan Idris Education University, Tanjung Malim, Perak, Malaysia*
[h]*Higher Education Leadership Academy, Ministry of Higher Education Malaysia, Bandar Enstek, Negeri Sembilan, Malaysia*

Abstract

Training of facilitators in Problem-Based Learning (PBL) is one of the most challenging tasks facing by higher learning institutions in Malaysia. It was time consuming and demanded high level of commitment from university leaders and training facilitators to prepare and equip the academics with proper skills in PBL. A number of institutions have taken their pro active efforts to train their academics in PBL through organized training sessions internally or externally. Unfortunately, some training sessions were unable to prepare and equip the academics with knowledge and skills to run a proper PBL at their respective institutions. In order to improve this situation, a group of PBL practitioners from three public universities are working together to develop a proper training module to train academics in PBL. The module was initially developed in 2010 and since then was applied in seven training sessions until end of 2012. A questionnaire set was developed in order to identify the effectiveness of this module based on 3C3R Model developed by Hung (2006). Findings show that the module has met six 3C3R standards, i.e. (1) having appropriate content related to PBL, (2) the problems are connected closely to the content and (3) the context of learning. Activities (4) required the participants to research, (5) reason and (6) reflect. The participants highly regarded the module and satisfied with the skills of using PBL and active learning experiences during the workshops.

Keywords: Problem-Based Learning, training of facilitators, Malaysian experience.

1. Introduction

Student-centered outcome-based learning has becoming so crucial for many institutions of higher learning in Europe since the inception of Bologna Process in 1999. As one of the most powerful student-centered outcome-based learning approaches, PBL has becoming a widespread learning method adopted by many institutions worldwide (Kolmos, 2010). Problem-Based Learning (PBL) has proven to be one of the most successful educational strategies adopted to improve the quality of learning among students at all levels and in various discipline areas. For many reasons this approach was used as a strategy for development in the globalized higher education (Kolmos & Graaff, 2007, Du, Graaff & Kolmos, 2009). It was gaining popularity in school curricula in United States (Pecore, 2012), higher learning institutions in Europe (Du, Graaff & Kolmos, 2009) and Asia (O'Grady, 2010). PBL is increasingly accepted as an active and innovative learning approach towards the development of more innovative education systems (Oon Seng, 2003). This approach to learning is an educational strategy where learning is driven by a problem and students work in teams to learn more about the problem and everything related to it, conduct a research, communicate to each other, apply numerous essential or generic skills and enjoy the fruits of active and collaborative learning. The lecturer or the teacher plays the role of a facilitator and motivator guiding students' learning towards intended learning objectives or outcomes (Savin-Baden & Major, 2004, Savin-Baden, 2003).

2. Statement of Problem

Over the years numerous studies conducted on the quality of graduates produced by public and private universities in Malaysia. Most of the graduates were discovered to be lacked of communication skills, English language proficiencies, problem solving skills, thinking skills and other important and common generic skills (Singh & Singh, 2008). Public universities graduates are seen as passive, old fashioned and unable to perform the challenging jobs. Failures during interview sessions surprisingly increased due to the inability of the graduates to communicate effectively (New Strait Times, September 2 & July 22, 2009). Traditional way of teaching and learning practiced for many decades at Malaysian higher learning

* Hussain Othman. Tel.: +60137792367 / +6074537933
E-mail address: hussain@uthm.edu.my

institutions was blamed for this situation. The over utilization of traditional delivery methods in form of lecturer-centered learning approach is seen as the most possible reason why knowledge, skills and values are failed to be delivered satisfactorily to the students. Many parties including the government, private sectors, educationists and society at large had sensed this situation and some steps have been taken to initiate significant changes at higher education level. The Malaysian Ministry of Higher Education (2007) had requested all public universities to take serious actions in tackling the problems of declining quality of graduates. One critical way to improve the quality of graduates is to improve the quality of teaching and learning through the adoption of PBL as one of major teaching and learning approaches at higher learning institutions. PBL is highly demanded because it captures many of the key principles of a constructivist perspective of learning and student-centered learning approaches (Lehman, George, Buchanan & Rush, 2006).

Numerous studies and observations were conducted on the implementation of PBL from many perspectives. Unfortunately, studies conducted on the training of facilitators or tutors are rarely taking forefront news in PBL community. In early 2000, research related to the training of staffs, facilitators or tutors is so limited (Murray and Savin-Baden, 2000). Nine years later the trend seems to be unchanged. For instance, there were only 3 out 77 research papers presented in Second International Problem-based Learning Symposium organized by Republic Polytechnic of Singapore related to the training of PBL facilitators (Proceeding of 2nd International Problem-based Learning Symposium, 2009). As the number of studies conducted on the training of facilitators is so small, the issues addressed were also limited to certain crucial topics. Study conducted by Murray and Savin-Baden (2000) is focusing on the role of staff development for the School of Nursing and Midwifery at the University of Dundee where PBL was introduced and implemented as part of its curriculum change. Dalrymple et al. (2007) as cited by Irene (2010) studied a staff development programme and process that focused on the core skills of PBL facilitators in the restructuring of a dental curriculum. Clancy (2005) as cited by Irene (2010) conducted study on the perceptions of lecturers about PBL and their readiness to implement PBL after attended PBL course and the Masstricht 7-step model. Some studies addressed the importance of identifying the stages of concern on PBL among staffs before introducing them with training session on PBL. Irene (2010) has conducted a study on the stages of concern among academic staffs of a private higher education in Malaysia on PBL.

The crucial issue discussed on the staff development and training in PBL is related to the selection of the most appropriate approach or method for training of facilitators in PBL. As commonly practiced, conventional approach of training is full with lectures, sometimes active and interactive but most of the times the participants were kept in silent mode by the so called "great speaker". At the end of training session each participant will be asked to evaluate the quality of speaker and the content of his delivery. The data collected might then be analysed in order to identify the effectiveness of the training session in terms of the content and invited speaker. If the analysis shows that the content is not adequate, it will be added some more in the next session. If the content is discovered to be so heavy, it will be reduced. If the speaker is not so good he will be replaced with someone else. If he is good then there will be another session for him.

From the perspective of a student, PBL is an active learning method based on the use of ill-structured problems as a stimulus for learning. It requires students to become responsible for their own learning. The role of a teacher is to facilitate student's learning. PBL sessions carried out in small, facilitated groups and structured learning process involving continuous discussion, argumentation, problem solving, peer assessment and reflection (Hmelo and Barrows, 2006). Same thing should be applied to the training of facilitators in PBL. Workshops or training sessions conducted among academics in PBL should provide effective professional development among them and address the true culture of students' learning (Pecore, 2012). As learning process is considered as more critical than learning product, facilitators attended PBL training session should be exposed to the real learning experiences of PBL. They should go through the PBL learning process so that they would be able to identify the crucial steps in handling PBL session and the potential problems and difficulties commonly faced by students. This is the best approach for training facilitators in PBL as Barrows and Lynda (2007) wrote, *"There should be no prior lecture or orientation about PBL or the role of the facilitator as there is no better way for participants to understand PBL and the role of the facilitator than to be involved as learners in the process from the outset and experience it for themselves".*

Following the principles outlined in Outcome Based Education (OBE), student-centered learning approaches are becoming the center for the transformation adopted in teaching and learning at higher education in Malaysia. A Centre for Learning and Teaching was established at Higher Education Leadership Academy (AKEPT), Ministry of Higher Education Malaysia to facilitate the transformation of teaching and learning methodologies through various programmes designed to develop and enhance professional knowledge and skills in teaching and learning (AKEPT, 2013). PBL is listed as one of the crucial student-centered learning approaches highly needed to complete the transformation in teaching and learning at Malaysian higher learning institutions. Hence, AKEPT has planned and organized a number of programmes including seminars, workshops and training sessions to develop leaders in PBL. PBL experts were appointed as trainers and facilitators to train academic staffs from public and private universities. Module was developed and tested during the training sessions. It was through these sessions the researchers are able to participate in developing and testing the module.

3. Module Development for Training of Facilitators in PBL

3.1. Module Content

Some important aspects were taken into consideration before the module was developed including the important content related to PBL, problem triggers, learning context, prior knowledge and skills and proper activities that enable the participants to gain first-hand knowledge and experience in PBL. Among the main topics included into the module are, introduction to Outcome Based Education (OBE), the foundation of PBL, educational process, problem solving skills, problem design and assessment in PBL. Each topic was then provided with a problem trigger designed by the group of facilitators based on the principles of 3C3R Model as proposed by Hung (2006). The problem triggers designed are having the combination of “content”, “context” and “connection” components (3Cs) and activities planned for each problem and topic contained the “researching”, “reasoning” and “reflecting” components (3Rs).

Among the outcomes intended to be achieved from this training session are the ability of the participants to; (1) identify the theoretical foundations of Problem-based Learning, (2) identify the advantages and challenges of implementing Problem-based Learning, (3) apply the principle of active learning through Problem-based Learning, (4) simulate learning activities using Problem-based Learning and (5) appreciate the varieties of learning experiences in Problem-based Learning.

The training session is scheduled for three days. In the first day, participants will explore three topics or units; introduction to Outcome Based Education (OBE), the foundation of PBL and educational process in PBL. Early in the first session participants will have to go through ice breaking activities enable them to get to know facilitators, other participants and get use to the PBL training approach up to the formation of a dynamic PBL learning group. Each participant will also be asked to reflect on their past teaching and learning experience. At this point facilitators will be able to get overview on the background of the participants including their experience in teaching and PBL.

3.2. Rotating Roles

Learning process starts with the presentation of problem by the facilitators. Working in their group participants will have to appoint appropriate person in charge. To make PBL experience is more real, each group is asked to appoint a facilitator, group leader, secretary, scribe and observers. In actual PBL scenario a facilitator is the teacher or lecturer. Other roles are representing students in their actual PBL scenario. These roles need to be rotated among the group members in order to let them experience different roles in each PBL session. Explanation on the role of each person in charge is provided inside the module and the participants can refer to the instruction. The training facilitators will also give details explanation about their roles with some examples from the video presentation. Each session will also be assessed by the observer and group facilitator. In actual PBL scenario, the observer is a student who was selected and given the opportunity to assessed other students through a systematic peer assessment procedure which also briefed by training facilitators at the beginning of the session.

Group’s facilitator should practice facilitating skills and not lecturing skills. They have to focus their attention on questioning participants’ logic and beliefs, providing hints to correct erroneous participants reasoning, providing resources for participants research, and keeping participants on task. In many occasions, facilitator will also have to assess participants learning activities and process, and guide them when they are required to conduct peer assessment process.

The roles of group leader is apply organizational, problem solving and communication skills, stimulate discussion, hone the group members’ ability to analyze and critique the information they bring to group discussions, monitor group process and progress and keep the group members on task.

Group’s secretary might be the one who is doing more jobs than others. He or she should provide personal administrative support to group organizational activities, organize and coordinate meetings and discussions, take, type and distribute minutes of meetings / discussion reports, maintain schedules and time management of the group, arrange and confirm group appointments, organize internal and external planning and projects, handle group’s materials, set up and maintain filing systems and work procedures, collate information and maintain databases, communicate verbally and in writing to answer inquiries and provide information, liaison with internal and external contacts and coordinate the flow of information both internally and externally.

Standing in front of the group or white board is the scribe. His or her jobs is to assist the secretary, listen carefully to the details of the discussion, write gist of discussion on the flip chart in a systematic way and easy to understand, participate in the discussion but focus more on the details of the discussion and not to forget to respond effectively to the group members behaviors that undermine the group process.

The rest of group members are having their own roles and sometimes they will have to be an observer or assessor. They have to observe how other participants take charge of their learning and learn cooperatively with their group members, observe how other participants define the learning issues of a problem, make decisions required by the problem, conduct research beyond their textbooks (perhaps outside class time), and propose solutions to problems and to assess their peers as required by the tasks.

3.3. PBL Learning Process

The star of attraction in this module is the newly invented PBL learning process called 5 Ladders of Active Learning. This new inventive PBL learning process was designed by the facilitators and copyrighted in 2012. In 5 Ladders of Active Learning, PBL learning starts at Ladder 1 in which the topic will be introduced to the participants through a presentation of a problem scenario for each unit. The participants then, work in the group to identify the learning issues using 3 Active Thinking Points (Identification of the facts, Ideas generation and Identification of learning issues). To conclude the Ladder 1 learning, the participants will complete the reflection form and soon climb to the Ladder 2.

At Ladder 2, the participants will have to embark on self-directed learning activities including reading the materials, watching the videos, summarizing the topic and to search for additional and supporting learning materials. To conclude the learning activities at Ladder 2, the participants will have to complete the reflection form. At Ladder 3, the participants will have to conduct the meeting and to report the result of their self-directed learning and prepare for the presentation at Ladder 4. To conclude the learning activities at Ladder 3 they will also have to complete the reflection form. At Ladder 4, the participants will have to present their result of learning. The presentation can be in many forms. It could be a parallel presentation or a single presentation or a forum discussion. Again, to conclude the learning activities at Ladder 4, the participants will have to complete the reflection form.

Ladder 5 is the final stage of learning for the topic. At this level the participants will be provided with a number of proper exercises to improve their learning. The exercises can be in many forms. It could be in form of interactive Multi Choice Questions in which the participants will be able to test their understanding and mastery of the topic through interactive approach. Finally, to conclude the learning activities at Ladder 5 and overall learning of the topic, the participants will have to complete the reflection form. There will also be an overall reflection on the course at the end of the session. The participants will have to complete overall reflection of their learning in the specific course and to answer a questionnaire set. The reflection and questionnaire set could be used by the instructors to identify the effectiveness of the overall learning as well as the module. Table 1 below shows overall learning process involved in 5 Ladder of Active Learning.

Table 1. PBL learning process in 5 Ladder of Active Learning

Step / Ladder	Ladder 1	Ladder 2	Ladder 3	Ladder 4	Ladder 5
Step 1	Introduction to case scenario / problem	Video input	Group meeting	Presentation	Exercises
Step 2	Identification of facts	Summary of the module	Reporting to the group	Peer assessment	Reflection on exercises
Step 3	Ideas generation	Overall module revision	Group's conclusion	Discussion	Reflection on the result of learning
Step 4	Identification of learning issues	Further self-directed learning	Presentation preparation	Conclusion	Reflection on the process of learning
Step 5	Reflection	Reflection	Reflection	Reflection	Overall reflection

4. Background of the Study

This study is addressing the importance of having a proper PBL training module developed based on a clear philosophical background, contained a comprehensive content related to PBL and delivered through a proper PBL learning process to achieve the intended training outcomes with truly PBL experiences. A group of researchers from three public universities are working together with Center for Learning and Teaching at Higher Education Leadership Academy (AKEPT), Ministry of Higher Education Malaysia to develop this module. The module was then used in seven training workshops conducted by the facilitators. Four workshops were organized by Center for Learning and Teaching at Higher Education Leadership Academy (AKEPT), Ministry of Higher Education Malaysia and three organized by public and private universities. The first workshop was conducted on December 2010 and the seventh workshop conducted on November 2012. Actual number of participants attended these seven series workshops are 248 participants. A study was planned on the implementation of this module and the data was collected using the instrument developed together with the module from the first workshop.

Main objective of this study is to identify the effectiveness of the module and to propose the best model for training of facilitators in PBL. Specifically, the study is intended to identify the effectiveness of the module based on 3C3R PBL problem design model as proposed by Hung (2006). Initially, 3C3R model is intended to identify the core component and process component of a problem designed for PBL exploration. The core components include the content, context and connection. The process components include researching, reasoning and reflecting. Based on this model, the study is intended to identify;

1. Core components contain in the module.
2. Process components reflect by the activities designed for the module.
3. The effectiveness of the module for training of facilitators in PBL .

This study is a descriptive survey research utilizing quantitative and qualitative data. The quantitative data is collected through a set of questionnaire developed by the researchers. The qualitative data is collected from the learning reflection described by the participants at the end of workshop session. The questionnaire set consists of 31 items representing 3C3R model, the six crucial components of a successful PBL exploration i.e. content, context, connection, researching, reasoning and reflecting. Four items represent "content" component (2, 10, 11 and 12), four items represent "context" component (13, 17, 29 and 30), three items represent "connection" component (3, 18 and 25), four items represent "researching" component (4, 7, 15 and 16), four items represent "reasoning" component (8, 9, 23 and 24) and twelve items represent "reflection" component (skills = 19, 20, 21, 22 and 28, values = 14, 26 and 27, overall = 1, 5, 6, and 31). Table 2 below shows the list of items belonging to each component.

Table 2. Items represent six crucial elements of a successful PBL

Component	No. of items	Items
Content	4	2, 10, 11 and 12
Context	4	13, 17, 29 and 30

Connection	3	3, 18 and 25
Researching	4	4, 7, 15 and 16
Reasoning	4	8, 9, 23 and 24
Reflecting *(Skills)*	5	19, 20, 21, 22 and 28
Reflecting *(Values)*	3	14, 26 and 27
Reflecting *(Overall)*	4	1, 5, 6, and 31

The questionnaire set is using 5 Likert scales 1=strongly disagree, 2 = Disagree, 3 = Uncertain, 4 = Agree and 5 = Strongly Agree. For the purpose of data analysis and interpretation the scales were then combined (1+2) and (4+5). The sets were distributed to all participants at the end of each workshop. However, only 209 respondents (84.3%) have replied and returned the questionnaire sets. The data was then analysed using SPSS software and reported in form of mean score and percentage.

5. Data Analysis and Findings

5.1. Demographic

Demographic data has recorded that out of 209 respondents, 70.3% (N=147) are from public universities and institutions and 29.7% (N=62) are from private universities and institutions. Respondents from Malaysian Polytechnics recorded the highest number with 24.4% (N=51). Respondents from University Malaysia Sarawak (Unimas) and University Malaysia Terengganu (UMT) are the lowest number with one respondent (0.5%) each. Table 3 below shows the list of institutions and the number of respondents.

Table 3. Respondents and institutions

Institution	Status	Total (N)	Percentage (%)
Polytechnics	Public	51	24.4
UTHM	Public	38	18.2
UniKL	Private	37	17.7
Community Colleges	Public	32	15.3
MMU	Private	28	13.4
Unimap	Public	9	4.3
USIM	Public	5	2.4
UPM	Public	3	1.4
UPSI	Public	2	1.0
UiTM	Public	2	1.0
Unimas	Public	1	.5
UMT	Public	1	.5
TOTAL		**209**	**100**

Table 4 listed the age range among respondents. The data shows that most of the respondents attended the workshops are between 25 to 35 years old (51.5%, N=108). Majority of the respondents are male (58.4%, N=122) and 41.6% (N=87) are female.

Table 4. Respondents Age

Age Range	Total (N)	Percentage (%)
Below 25	6	2.9
25-30 years old	54	25.8
31-35 years old	54	25.8
36 - 40 years old	32	15.3
41-45 years old	24	11.5
46-50 years old	18	8.6
51-55 years old	16	7.7
56-60 years old	4	1.9
Over 60	1	.5

TOTAL	209	100

Most of the respondents are having 1-5 year experience in teaching. Data in Table 5 recorded 44.5% (N=93) of the respondents are having 1 to 5 years of teaching experience. Few respondents (5.7%, N=12) are having more than 25 years of teaching experience.

Table 5. Teaching Experience

Teaching Experience	Total (N)	Percentage (%)
1-5 year	93	44.5
6-10 year	42	20.1
11-15 year	30	14.4
16-20 year	21	10.0
21-25 year	11	5.3
More than 25 years	12	5.7
TOTAL	**209**	**100**

As shown in Table 6, respondents attended PBL workshops are coming from various disciplines areas from engineering to medical, humanities and social science. However, based on the data it shows that engineering academics recorded the highest number of respondents attended the workshops with 44.5% (N=93) and followed by humanities studies (9.1%, N=19), information technology (7.2%, N=15), medical (7.2%, N=15), management (6.2%, N=13) and science studies (4.8%, N=10). The rest recorded lower number below than 10 respondents.

Table 6. Discipline Areas

Discipline Areas	Total (N)	Percentage (%)
Engineering	93	44.5
Humanities	19	9.1
Information Technology	15	7.2
Medical	15	7.2
Management	13	6.2
Science Studies	10	4.8
Accounting	8	3.8
Education	7	3.3
Computer Science	7	3.3
Finance	5	2.4
Architecture	5	2.4
Social Science	4	1.9
Economics	4	1.9
Mathematics	3	1.4
Total	**209**	**100**

In terms of academic qualification, most of the respondents are having Master degree. The data in Table 7 recorded 62.2% (N=130) of the respondents are having Master degree as compared to 12.4% (N=26) respondents having Ph.D, 24.4% (N=51) are having Bachelor degree and only 1% (N=2) of them are having Diploma.

Table 7. Highest Academic Qualification

Academic Qualification	Total (N)	Percentage (%)
Ph.D	26	12.4
Master	130	62.2
Bachelor	51	24.4
Diploma	2	1.0
Total	**208**	**100**

Finally, Table 8 recorded one of the most important demographic data for this study, the data on prior experience of the respondent in PBL. The data shows that majority of the respondents are lack of experience in PBL. A staggering number of them (86.6%, N=181) are not having any experience in PBL and 7.2% (N=15) are having 1-2 year experience in PBL. Only a small number of them (6.2%, N=13) are having experience in PBL more than 3 years.

Table 8. PBL Experience

PBL Experience	Total (N)	Percentage (%)
None	181	86.6
1-2 years	15	7.2
3-4 years	6	2.9
5-6 years	3	1.4
9-10 years	1	.5
More than 10 years	3	1.4
Total	**209**	**100**

5.2. Core Components of the Module

Content, context and connection are the core components of the 3C3R model. These components are primarily concerned with the issues of appropriateness and sufficiency of content knowledge, knowledge contextualization, and knowledge integration (Hung, 2006).

5.2.1. Content Component of the Module

Four items related to the content component of the module. Participants were asked to identify whether, (1) the content of the module is complete, inclusive of knowledge, skills and values, (2) enable them to increase their understanding on what is PBL, (3) enable them to incorporate PBL into curriculum and (4) increase their understanding on how to design a good and appropriate problems. Table 9 shows mean score of each item. Mean score of each item exceeded 4.0 except item 12 (3.98, SD0.665) which is slightly lower than 4.0. The cumulative percentage of agreement is 88.07% with high mean score recorded (4.13). This proves that the content of the module is sufficient and appropriate for learning and understanding PBL.

Table 9. Mean Score for Content Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
2.	Content…complete and inclusive of the knowledge, skills and values	89.5% (187)	9.1% (19)	1.4 % (3)	4.11 (0.603)
10	Content...increases understanding of "what PBL is"	92.9% (194)	6.7% (14)	0.5% (1)	4.33 (0.621)
11	Content …increases understanding to incorporate PBL inside the curriculum	87.1% (182)	12% (25)	1% (2)	4.11 (0.633)
12	Content and activities…increase understanding on how to design a good and appropriate problems	82.8% (173)	14.4% (30)	2.9% (6)	3.98 (0.665)
Cumulative Percentage / Mean		**88.07%**	**10.55%**	**1.45%**	**4.13**

5.2.2. Context Component of the Module

The module was designed purposely for the participants to experience PBL onset. Thus, PBL learning process using 5 Ladders of Active Learning was applied all the way with fully active participation from the participants. It was from this context the participants will be able to master PBL content and skills easily and enable them to apply it at their institutions effectively. Four items related to the context component were posted to the respondents. The data in Table 10 shows that all items exceeded mean score 4.0. The module is proven to be highly effective in training skills of implementing PBL with mean score 4.02 (SD 0.567). Participants were also agreed that the module has increased their confidence to start implementing PBL (Mean score 4.02, SD 0.600) and motivation to embark in teaching and learning innovation (Mean score 4.33, SD 0.538). In general, the module is successfully introduced PBL to the participant (Mean score 4.21, SD 0.623). The cumulative percentage and mean score is high (89.72% / 4.15). This shows that the module is having a high level of context component and much better than conventional lecture-based training.

Table 10. Mean Score for Context Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
13	Increases skills to implement PBL at institution	86.1% (180)	13.4% (28)	0.5% (1)	4.02 (0.567)

17	Increases confidence to start implementing PBL	85.2% (178)	13.9% (29)	1% (2)	4.02 (0.600)
29	Increases motivation to involve in new teaching and learning innovation	96.7% (202)	3.3% (7)	0	4.33 (0.538)
30	Successfully introduced PBL to the participants & to implement PBL at their institution	90.9% (190)	8.1% (17)	1% (2)	4.21 (0.623)
Cumulative Percentage / Mean		**89.72%**	**9.67%**	**0.62%**	**4.15**

5.2.3. Connection Component of the Module

According to Hung (2006), the connection component functions to interweave the concepts and information within the conceptual framework, and content into contexts. It was not so easy to identify the connection parts that highly effective to interweave the concepts and information and within the conceptual framework and content into contexts unless after a proper application of the PBL learning processes in the module. Three items were posted to the respondents in order to identify their perspectives on the connection component exists inside the module. Data in Table 11 shows high mean scores. The module has attracts the participants to take part in learning activities means there is a strong connection between problems presented to the participants with the content and context of learning. High cumulative percentage and mean score (94.4% / 4.28) shows that this module is having a strong connection component.

Table 11. Mean Score for Connection Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
3.	Attracts participants to take part in learning activities	93.8% (196)	5.7% (12)	0.5% (1)	4.26 (0.582)
18	Increases learning motivation to learn more about PBL	97.1% (203)	2.4% (5)	0.5% (1)	4.21 (0.494)
25	Increases ability to manage and execute the given tasks	92.3% (193)	7.7% (16)	0	4.38 (0.625)
Cumulative Percentage / Mean		**94.4%**	**5.27%**	**0.3%**	**4.28**

5.3. Process Components of the Module

Process components in 3C3R model were designed to facilitate mindful and meaningful engagement of participants in PBL. Researching, reasoning and reflecting are the three dynamic elements in process components. There are two functions of these dynamic components. First, the main function of the processing components is to serve as an activator to guide the learners to take advantage of the design of the core components. Second, processing components function as a calibration system to guide students' learning toward the intended learning outcomes, adjust the level of cognitive processing required during the course of PBL in accordance with the cognitive readiness of the learners, and alleviate the issue of students' initial unfamiliarity or discomfort with PBL. The general purpose of the 3Rs is to facilitate meaningful engagement in scientific inquiry and problem-solving processes and to cultivate effective and efficient learners and problem solvers (Hung, 2006).

5.3.1. Researching Component of the Module

A specific PBL learning process was designed in 5 Ladders of Active Learning to open space for the participants to embark in research activities. It was in Ladder 2 where participants will be able to conduct self-directed learning and research. The main task in this stage is to search for necessary information within the domain as preparation for the next stage of the problem-solving process which is group reporting and discussion at Ladder 3. In order to identify the level of research component in the module four items were posted to the respondents. The result of the survey shows that the module contains high level of research component. The module challenges the participants to search for new knowledge (Mean score 4.20, SD 0.634), providing more opportunities for the participants to polish their self-directed learning skills (Mean score 4.20, SD 0.523), encourages to search for additional learning resources (Mean score 4.14, SD 0.584) and to use ICT for searching the resources (Mean score 4.14, SD 0.654). Cumulative percentage and mean score is high (91.5% / 4.17). Table 12 shows the data related to researching component in the module.

Table 12. Mean Score for Researching Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
4	Challenges ability to search for new knowledge	90% (188)	9.1% (19)	1% (2)	4.20 (0.634)
7	Provides more opportunities to polish self-directed learning skills	95.2% (199)	4.3% (9)	0.5% (1)	4.20 (0.523)
15	Encourages to search for additional learning resources	90.9% (190)	8.1% (17)	1% (2)	4.14 (0.584)
16	Encourages to use ICT for searching of resources	89.9% (188)	1.4% (33)	0.5% (1)	4.14 (0.654)
Cumulative Percentage / Mean		**91.5%**	**4.5%**	**0.75%**	**4.17**

5.3.2. Reasoning Component of the Module

Reasoning is the processing component that promotes application of knowledge acquired from researching related information and the development of the learners' problem-solving skills (Hung, 2006). Activities designed in Ladder 1 and Ladder 2 enabled the participants to analyze information, generate and test hypotheses and solutions to the problems. Through this reasoning process they had put their knowledge into practice instead of only memorizing it. During this process, participants as problem solvers engage in the cognitive activities that enable them to solve and learn many things from the problem. In order to identify the level of reasoning embedded in the module, four items were posted to the participants. The data in Table 13 shows that all items recorded high mean scores above 4.20 with the cumulative mean score 4.23. This evidently shows that the module is having high level of reasoning component.

Table 13. Mean Score for Reasoning Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
8	Provides more opportunities to increase group learning skill	95.7% (200)	4.3% (9)	0	4.23 (0.514)
9	Increases level of knowledge through brainstorming and group sharing	94.7% (198)	4.3% (9)	1% (2)	4.24 (0.574)
23	Increases problem solving skill	93.8% (196)	5.7% (12)	0.5% (1)	4.22 (0.560)
24	Increases the level of thinking skill	95.7% (200)	3.3% (7)	1% (2)	4.22 (0.569)
Cumulative Percentage / Mean		**94.97%**	**4.4%**	**0.62%**	**4.23**

5.3.3. Reflecting Component of the Module

Reflecting on any event or occasion that happened to us by nature will improve our knowledge retention and skills. Same thing goes to the reflection activities done by the learners in PBL. Through reflecting on the knowledge they have constructed and learning process throughout the PBL learning cycle, learners have an opportunity to organize and integrate their knowledge into a more systematic conceptual framework. Reflecting involves three main metacognitive activities; knowledge abstraction, summary, and self-evaluation. The cognitive activities of abstracting, summarizing and organizing knowledge enhance learners' conceptual integration and retention of the knowledge. Self-evaluation enables the learners to improve their problem solving skills and learning skills.

For the purpose of understanding the level of reflecting component in the module, twelve items were posted to the respondents. Result of the survey from these items will also be able to show the effectiveness of this module. The reflecting component from the items is divided into three groups, 5 items on skills, 3 items on values and 4 overall reflection items. In first group, respondents are required to response on a number of essential PBL skills believed to be mastered at the end of training session. The skills include facilitation skills, team working skills, managing group learning, teaching innovation skills and communication skills. The data recorded high mean scores for all five related items (above 4.10) with high cumulative percentage and mean score (94.16% / 4.29) as shown in Table 14. This proves that the module is highly effective in developing these essential PBL skills.

Table 14. Mean Score for Reflection on Skills Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
19	Increases communication skills	95.2% (199)	4.8% (10)	0	4.44 (0.587)
20	Increases team working skills	95.7% (200)	4.3% (9)	0	4.32 (0.551)
21	Increases facilitation skills	90.9% (190)	8.6% (18)	0.5% (1)	4.17 (0.585)
22	Increases skills of managing group learning	92.8% (194)	7.2% (15)	0	4.22 (0.560)
28	Increases teaching innovation skills	96.2% (201)	3.8% (8)	0	4.28 (0.530)
Cumulative Percentage / Mean		**94.16%**	**5.74%**	**0.1%**	**4.29**

In second group of reflecting component, respondents are posted with three items related to the mastery of values in teaching and learning. After having a three day training session the module is expected to be able to inculcate and increase noble values, wisdom and creativity. The result of the survey shown in Table 15 recorded high mean scores for all three items related to the mastery of values (above 4.20) with high cumulative percentage and mean score (92.03% / 4.27). This evidently proves that the module is highly effective in inculcating and increasing noble values, wisdom and creativity through PBL exploration.

Table 15. Mean Score for Reflection on Values Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
14	Inculcates better noble values	86.1% (180)	12.4% (26)	1% (2)	4.24 (0.700)

26	Increases ability to act wisely	93.3% (195)	6.2% (13)	0.5% (1)	4.22 (0.571)
27	Increases creativity in teaching and learning	96.7% (202)	2.9% (6)	0.5% (1)	4.28 (0.539)
Cumulative Percentage / Mean		**92.03%**	**7.16%**	**0.67%**	**4.27**

Finally, in third group of reflecting component, the study is intended to identify the overall effectiveness of the module. For this purpose four related items were posted to the respondents. First item (item no. 1), respondents were asked to give their opinion on the structure of the module. Mean score recorded for this item is 3.94 (SD 0.706). Although the score is slightly lower than 4.0, it was within the range of high mean score and it shows that the structure of this module is comparatively easy to follow despite majority of the respondents are lacking of PBL experience as shown in Table 8 previously where 86.6% of participants do not have any PBL experience before attending the course. Second, most of the respondents agreed that the activities and tasks designed in the module are interesting. High mean score (4.36, SD 0.613) is recorded for this item (item no. 6). Thus, this evidently shows the active parts of the module that enable the participants to learn actively and pleasantly. Third (item number 5), respondents were asked to evaluate the effectiveness of the module. The result of the survey recorded high mean score (4.29, SD 0.600). This clearly shows that the module is highly effective as compared to the traditional lecture approach. Finally, the final item (item number 31) is intended to ask sincere response from the respondents whether they would prefer to use this module in the future. The result clearly shows that most of the respondents are preferred to use this module rather than traditional lecture approach. Mean score recorded is 4.37 (SD 0.645).

Table 16. Mean Score for Overall Reflection Component

Item No.	Statement: The Module…	Agree % (N=)	Uncertain % (N=)	Disagree % (N=)	Mean Score (SD)
1	Structure...easy to follow	78.5% (164)	17.7% (37)	3.3% (7)	3.94 (0.706)
5	More effective compare to the traditional lecture mode	93.3% (195)	6.2% (13)	0.5% (1)	4.29 (0.600)
6	Activities and tasks... are interesting…	92.9% (194)	7.2% (15)	0	4.36 (0.613)
31	Preferred by the participant compare to the traditional lecture approach	90.5% (189)	9.1% (19)	0	4.37 (0.645)
Cumulative Percentage / Mean		**88.8%**	**10.05%**	**0.95%**	**4.24**

Based on the responses and result of the survey on reflecting component, there was a clear indication that this module is having a high level of reflecting component as recorded in high cumulative mean score (4.24). The reflections described by the participants itself are the most valuable sources for them to be used as input in continuous improvement and life-long learning exploration. Facilitators on the other hand could use these reflections for the improvement of the module quality and presentation in the future.

6. Discussion

Within two years of PBL training of trainers programme conducted by the researchers there were more than 200 participants from all over Malaysia undergone the courses. This number is too small to initiate greater changes in teaching and learning at Malaysian higher education. However, it was a very meaningful experience for most of the participants attended the courses since for the first time they have been learning PBL using PBL approach. As the data revealed, majority of the participants (86.6%) having no experience in PBL and it was an interesting experience for them to meet PBL in the first time through PBL approach. Reflections collected from the participants listed in Table 17 clearly show how the module had effectively introduced PBL to these inexperience participants.

Table 17. Overall Reflection on the Module

Institution	Discipline Area	Teaching Experience	PBL Experience	Overall Reflection
Public	Engineering	10 years	none	*"Overall it is interesting. Increase my understanding because the learning process is conducted through real situation."*
Public	Science	10 years	none	*"I love the content and the information is very valuable. Workshop learning activities are very good and I really understand how to implement PBL."*
Public	Engineering	3 years	none	*"An effective workshop delivery and participants were given a clear description and real situation of PBL"*

Private	Medica l	4 years	none	*"I will apply PBL in my teaching and learning activities"*
Private	Engine ering	25 years	none	*"The workshop has been tremendously helpful in not only giving exposure and experience in PBL but proves that PBL is indeed comprehensive and is the most effective student centered learning approach. Thank you very much for the training and invaluable hands-on experience"*

Holloway (2003) as cited by Irene (2010) pointed that there are seven stages of concern teachers may experience when a new educational initiative or training programme is introduced; (1) Awareness, (2) informational, (3) personal, (4) management, (5) consequence, (6) collaboration and (7) refocusing. Teachers at awareness level are not interested or concerned with any innovation introduced to them. When reached informational level, they are becoming interested in some information about the change. At personal level, they want to know personal impact of the change. At management level, they are very concerned about how the change will be managed in practice. At consequence level, they are interested in the impact on students or school. At collaboration level, they are interested in working with colleagues to make the change effective and finally at refocusing level they begin to refine the innovation to improve student learning results.

As the data revealed that the participants are very satisfied with the module and training sessions they have attended. Definitely this shows that the module has attained the approval from the participants and some improvements might be necessary to be made in the near future through continuous quality improvement (CQI) activities. On the other hand, there is another important issue that needs to get more attention, the possible transformation expected from the participants after they have completed the workshops. This issue is very interesting to be investigated further. Based on preliminary data, the transformation took place among participants has reached second level of Holloway's seven stages of concern, i.e. informational level. Most of the participants show their interest on PBL and are ready to make the changes to apply PBL. Participants' reflections in Table 18 clearly show their concern and interest on PBL and their readiness to apply PBL.

Table 18. Interest on PBL at Informational Level

Institu tion	**Discipli ne Area**	**Teachi ng Experience**	**PBL Experi ence**	**Reflection at Informational Level**
Public	Enginee ring	7 years	6 months	*"Got clear picture and steps to implement PBL. Got idea on what has to be planned in order to apply PBL in teaching and learning"*
Public	Enginee ring	1 year	none	*"The short course is really helping me to build my confidence to start teaching and I am so excited about PBL and look forward to apply it rather than conventional teaching methods."*
Public	Enginee ring	22 years	3 years	*"Congratulations! This workshop is very informative, interesting and giving me opportunities to introduce PBL as a new way of teaching and learning."*
Private	Medical	4 years	none	*"I will apply PBL in my teaching and learning activities"*
Private	Manage ment	9 years	6 months	*"I have used PBL module designed by others without really understand how and why. This module and course give me clear view what actually I need to do."*

7. Conclusion

The module development and training sessions conducted over two-year period among Malaysian academics to become effective facilitators in PBL have shown the fruitful result. The module is highly regarded as one of the best modules developed to train PBL facilitators in Malaysia. It was also attracted attention from all levels including from the Center for Learning and Teaching at Higher Education Leadership Academy (AKEPT), Ministry of Higher Education Malaysia. Most of the researchers for this module are the module developers themselves and were also contributed to the implementation of this module throughout these two years. Being the persons in charge for this module, they were trusted to contribute further for the development of more challenging module for training of master trainers in PBL at national and international levels. This responsibility was handed over by Center for Learning and Teaching at Higher Education Leadership Academy (AKEPT), Ministry of Higher Education Malaysia to be executed from January to December 2012. Based on prior experiences of developing and implementing the module for training of facilitators, this group of module developers managed to develop a comprehensive module for training of master trainers at national and international levels using the same principles adopted for the previous module for training facilitators. 2013 is the first year of implementation for this module by AKEPT in training of master trainers in PBL. It was expected thousands of Malaysian and foreign academics will benefit from this new module. Definitely, more studies are waiting in the future to be conducted on training of trainers in PBL from various aspects including through the application of PBL models. The application of Hung 3C3R model in this study is still considered as a preliminary attempt. This model could also be applied in future studies with more comprehensive analysis and looking from various perspectives.

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References

AKEPT (2013), Higher Education Leadership Academy, Ministry of Higher Education Malaysia. Available at: http://www.mohe.gov.my/akept/about_9.html

Barrows, Howard S and Lynda, Wee Keng Neo (2007), *Principle and practice of aPBL*, New Yor: Pearson.

Center for Educational Development (2009), Proceeding of 2nd International Problem-based Learning Symposium, Republic Polytechnic, Singapore, 1-778.

Du, Xiangyun, Erik De Graaff, Anette Kolmos (2009). PBL – Diversity In Research Questions And Methodologies, In *Research on PBL Practice in Engineering Education,* Sense Publishers, 1–7.

Fewer unemployed graduates expected, New Strait Times report, a Malaysian news paper, 22 July 2009.

Glen O'Grady, Glen (2010), PBL in Asia, *Reflections on PBL*, Issue 9, January, 3.

Graaff, Eric de and Anette Kolmos (2003), Characteristics of Problem Based Learning, *International Journal of Engineering Education,* Vol. 19, No. 5, 657-662.

Graduates: too choosy about job, New Strait Times report, a Malaysian news paper, 2 September 2009.

Hmelo-Silver, Cindy E. and Howard S. Barrows (2006), Goals and Strategies of a Problem-based Learning Facilitator, *The Interdisciplinary Journal of Problem-based Learning,* Volume 1(1), 21-39.

Hung, Woei (2006). *The 3C3R Model: A Conceptual Framework for Designing Problems in PBL*, The Interdisciplinary Journal of Problem-based Learning, Volume 1, no. 1, Spring 2006.

Irene, Tan Ai Lian (2010), Determining the Readiness of Staff for PBL Training and Development, *Reflections on PBL,* Issue 9, January 2010, 4-9.

Kolmos, Anette (2010), Premises for Changing to PBL, *International Journal for the Scholarship of Teaching and Learning,* Vol. 4, No. 1, 1-7.

Kolmos, Anette, Xiangyun Du, Jette E. Holgaard & Lars Peter Jensen (2008), *Facilitation in a PBL Environment,* Center for Engineering Education Research and Development, Aalborg University.

Lehman, James D. Melissa George, Peggy Buchanan, Michael Rush (2006), Preparing Teachers to Use Problem-centered, Inquiry-based Science: Lessons from a Four-Year Professional Development Project, *The Interdisciplinary Journal of Problem-based Learning,* Volume 1(1), 76-99.

Ministry of Higher Education Malaysia, (2007), *Humanistic Skills Guidelines,* Universiti Putra Malaysia.

Murray, I. & Savin-Baden, M. (2000). Staff development in Problem-based Learning, *Teaching in Higher Education*, 5(1), 107-126.

Onn Seng, Tan (2003). *Problem-Based Learning Innovation: Using Problem to Power Learning in the 21st Century.* Singapore: Thomson.

Pecore, J. L. (2012). Beyond Beliefs: Teachers Adapting Problem-based Learning to Preexisting Systems of Practice. *Interdisciplinary Journal of Problem-based Learning,* 7(2), 1-27. Available at: http://dx.doi.org/10.7771/1541-5015.1359

Savin-Baden, Maggi & Claire Howell Major (2004). *Foundations of Problem-based Learning.* Berkshire: Open University Press.

Savin-Baden, Maggi (2003). *Facilitating Problem-based Learning: Illuminating Perspectives.* Berkshire: Open University Press.

Singh, Gurvinder Kaur Gurcharan & Sharan Kaur Garib Singh (2008). Malaysian Graduates' Employability Skills, *UNITAR e-Journal*, Vol. 4, No. 1, 15 – 45.

Project BEE: Concept and Model for Service Learning in Engineering

Young Bong Seo *, Jiin Eom, O-Kaung Lim

Innovation Center for Engineering Education , Pusan National University, Busan 609-735, Korea

Abstract

Project BEE-Creativity Station' is the creative convergence design education which involves engineering services based on different majors. The basic structure of service learning is divided into five parts based on topics with 29 detail missions. Participants should find problem and define solving issue to serve in local site. Students can refer to the schedule book to get information about various missions each project requires. Each team found out the most crucial issue of TMB village and defined the problem by themselves. The main issues are rubbish problem, no air circulation, insect problem, drying up the rice residue, drying up clothes in the rainy season and drainage. Through this project, 10 teams made 10 items related with trash, clothes dryer, rice dryer, temperature and sewer cover for engineering service and installed successfully. All participants increased the program outcomes like as global capability, technology appliance, interpersonal skill, synthetic thinking, communication skill and self-management capability.

Keywords: Project BEE, Creativity Station, engineering service learning, program outcomes, basic job ability, Teaching Manual, ABET, ABEEK;

1. Introduction

BEE represents 'Beyond Engineering Education'. Project BEE is designed for those who want to serve others through engineering (Seo et al., 2013). 'Creativity Station' is the creative convergence design education which involves engineering services based on different majors. To maximize its effects, we need to train the participating students beforehand in the areas of 'creativeness', 'writing for engineers', 'speaking for engineers', 'understanding local culture', and etc.

Since 2009, we have had four projects of engineering services in Surabaya, Indonesia; the first, 'contest for engineering service learning' (Choi et al., 2011): the second, 'design project for engineering services' (Seo et al., 2012): the third, 'design academy for engineering services' (Seo et al., 2013): the fourth, 'engineering service consulting'. With the experiences gained, we successfully finished the 'Creativity Station', technology-based creative convergence program, in January 2013, designed for college students from 13 universities in Southeastern Korea, EEPIS in Indonesia and UTM in Malaysia. The main spirit of the program remains the same in that the students from the different countries team up in an international convergence capstone to help the local community. That is to say, the main focus of the program is still on 'engineering', 'service', and 'education'. A little modification has been applied, though, to the way program is operated.

To systemize the learning process and its effects, we made the student guidebook and distributed it to the students. Through surveys done before and after the project, we could prove the effectiveness of the student guidebook. The success of a program requires guiding the students well. Since one leader is not enough to do the job perfectly, we need to appoint several managers to take charge of each team. When organizing a project, we could design it in such a way that merely following the program protocol leads to the desired educational goals. An alternative is that we induce the desired achievements in various ways by having only the rough outline of the program and by encouraging the students to be autonomous in their judgments and actions. Roles are divided here. To plan the program well is up to the planners. To support the students well is the job of the managers. And the participating students are the ones who actually achieve the desired goals. Another reason for the need of a teaching manual might be found when we want to carry out our project in another college or institution. Setting up the program schedule is relatively simple; you can refer to various materials. However, mere reference to other materials is not enough to assure the transfer of the accumulated knowhow, and cannot guarantee desired educational effects accordingly. With our hands-on experience, we can help others not to go through the same trials and errors. Their saved energy could be directed toward creating more similar programs with the same objective. If more and more universities operate similar programs, we may exchange students to share experiences.

Furthermore, we hope to organize an academic society in which a lot of people gather on a yearly basis to share experiences of engineering services, achievements and knowledge. We presented a concept of service learning of project BEE which is comprised in five detail projects at Section II. Basic structure of Project BEE is introduced at Section III. We introduced the student activities in Creativity Station 2013 in Indonesia at Section IV. In Section V, the achievements of program outcome for

* Corresponding Author name. Tel.: +82-51-510-3183
E-mail address: ybseo@pusan.ac.kr

the whole program was analyzed according to ABET. Finally, some conclusion and remarks was depicted in order to enhance the given project.

2. Concept of service learning

This project is divided into five parts based on topics. 'Project 1.0: Make the best team' is aimed at making the best teams which can serve as the foundation of the whole project. A lot of things are taken into account before we separate the participants into teams. For optimal team organization, we consider many aspects including students' majors, talents, and even personality types. In 'Project 2.0: Look at problems from different viewpoint', we train students to be able to look at problems from different perspectives through various learning processes including creative invention method, design, and engineering writing. They will learn by experience how to approach a problem differently, rather than be merely taught how to come up with a pre-determined solution to each given problem. In 'Project 3.0: Solve local problems', we help solve the problems local residents are facing. The process includes 'deriving a new idea', 'product design', 'purchasing materials', 'making of products', 'writing instruction manuals for products', and 'installment of products'. 'Project 4.0: Be one with the local community' is focused on effective communication. To cooperate with the local community in an organic way, it is absolutely necessary to let the locals know who you are and why you are there in the community. Lastly, 'Project 5.0: Organize ideas and share them' helps the students evaluate their own products, organize and share ideas so that follow-up projects of the kind can continue in the future.

ʹGiving stamps' is one of the most important elements necessary for completing the missions specified in the manual. Every mission has a goal. If an assigned mission is completed, stamps are given as rewards. Stamps are given as reward for completion of concrete missions, such as 'idea development' and 'product making'. 'Giving stamps' is also effective for making participants keep the set schedule, such as 'daily meeting', and 'journal writing'; they will try not to be late to get stamps. And the project can proceed on schedule. For long-term team missions, each team is responsible for time allotment. The organizer only checks the given assignments on a regular basis. The intended goal is to hold the students accountable for the process as well as the results of each task. As the project proceeds, students will get conscious of the importance of teamwork more and more, since penalties are given to a team in case of any absence or failure of their members. This will help improve the entire performance of the project, not to mention enhance teamwork. Managers may advise their teams to acquire all the stamps allotted for each mission. So if their team members fully utilize the given time and meet all the criteria for getting stamps, managers give their signature. 'Stamps' divide the roles between staff members and managers. Managers are interested in improving performance of the project. Staff members, on the other hand, focus on smooth operation of the whole project. Sometimes, there comes a situation where there is a conflict between going for better performance and keeping the schedule. If that kind of situation arises, the schedule always takes precedence, because resources are limited in terms of time, human resources, and budget. In this case, staff members are authorized to give out stamps to facilitate the process.

Each part of the teaching manual is organized in the following order: outline, time, questions, objective, Materials, preparation, education, and key points.

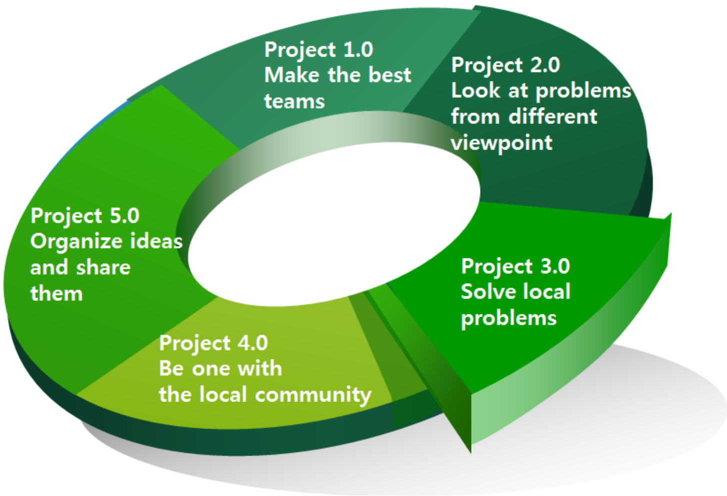

Figure 1. Basic Structure of service learning model

- 'Outline' contains introduction, objective and rough explanation of the mission.
- 'Time' indicates the total time required for the completion of each mission. It may be adjusted according to the total schedule.
- 'Questions' are the things to be asked of the students before the mission starts. Questions are used to arouse interest and curiosity of the students.
- 'Objective' shows the goals to be reached through a mission at minimum requirements. Students need to be fully aware of the given environment to meet this.

- 'Materials' identifies the materials needed for the completion of the given mission, and should be prepared before each mission starts.
- 'Preparation' is what managers are required to know before they start education.
- 'Education' is listed in the time order, and deals with the things to be covered for mission completion. In a certain stage, tips or references are attached to help with education
- 'Mission' describes the mission assigned to the students in the student guidebook. It also describes the rules for stamp-giving.
- 'Assignment' is given to each individual student. They need to do that after completing a mission.
- 'Key points' are the things which require special attention in the course of 'education'. Managers can assess the educational effects based on these questions.
- 'References' are the things to be referred to during the mission or related to the things having been covered though previous activities.

Participants are provided with the schedule book and the guidebook. They can refer to the schedule book to get information about various missions each project requires. The guidebook shows the students various assignments. The teaching manual provides additional explanation and will help the students understand the guidebook better. 'Learning by experience' is the key in this project. Therefore, we cannot emphasize too much the importance of full utilization of the student guidebook and the teaching manual.

3. Model of service learning

Whole contents of teaching manual are consist of 29 detail missions in Table 1. The duration for project work and division of time for five stages are also denoted. All missions are described in detail how to educate participants in viewpoint of manager. Especially, several missions from finding local issues to installing products should have to follow the mission flow chart in Figure 2. Some materials may not be available on the market against expectations. In this case, the students in charge of the purchase need to find the alternatives in a short time. The team which has failed the buy all materials can go back to product design only one time. That is to say, they cannot go backward and start from a different idea they thought of and continue on with designing, making purchases, and producing after this stage. Students should have to get the permission first from the owner of the building before installation. They can show the owner the product instruction written in the local language. When the installation is complete, they should check for operation and stability of the product. If anything goes awry, don't delay remedial action. Correct the trouble spots immediately as they appear to prevent future problems.

Table 1. Contents of teaching manual

Chapter	Content	Time (hr.)
Project 1.0 Make the best teams	• Personality test	1
	• Placement of team members	1
	• Team building	2
	• Teamwork game	3
Project 2.0 Look at problems from different viewpoint	• Creative invention method	1
	• Design education	1
	• Academic engineering	1
	• Safety education	1
	• Language education	4
	• Balloon art	2
Project 3.0 Solve local problems	• Finding local issues	2
	• Deriving a new idea	2
	• Product design	5
	• Purchasing materials	2
	• Making a product	11
	• Writing product descriptions	2
	• Installing product	4
Project 4.0 Be one with the local community	• Meet neighborhood	1
	• Welcoming dinner	2
	• Morning walk	7
	• Free team mission	6
	• General service	1
	• Farewell dinner	2

Project 5.0 Organize ideas and share them	• Self-reflection • Product exhibition • Selecting the best member • Daily journal • Daily meeting • Final presentation	2 3 1 4 7 2

3.1. Make the best teams

Every activity should start with well-formed teams. There are a lot of things to be considered in grouping students into different teams: members' different majors, talents, and even personality types. For better results, efforts for teamwork building are needed from the beginning stage. A well-formed team gets more and more competitive, and can be a barometer for the eventual level of excellence in performance. But for short-term projects which last less than two weeks, we cannot wait for teamwork to develop of itself. Therefore, to systemize the process of team formation and to accelerate teamwork building, right after the selection process for participants is over, we give them the personality test, based on which individuals are placed in a certain team. Team making and teamwork building should not be delayed. These are the first things to be done on arrival at the site of the project.

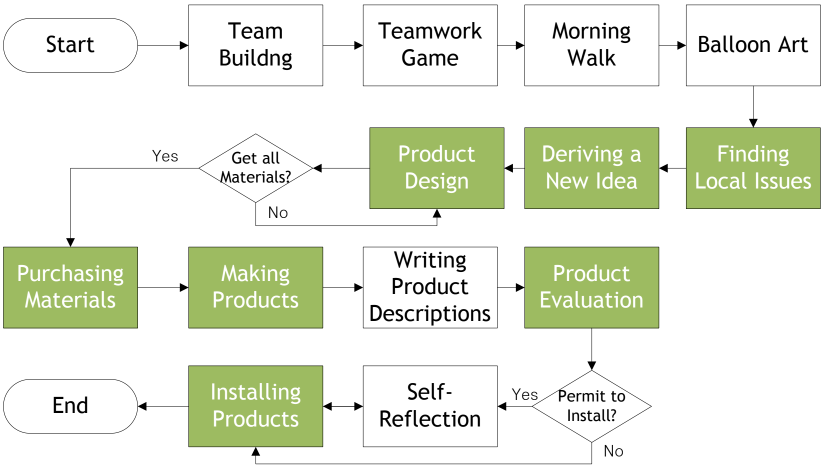

Figure 2. Mission flow chart of service learning

3.2. Look at problems from different viewpoint

We are so used to given problems and have been trained to look for pre-determined solutions to the problems. This routine process of problem-solving taught in traditional educational institutions hinders effective progression of this project. Students need different perspectives to approach problems while considering various aspects, identifying problems sometimes, and thinking about how the problem will fit in the whole system. It is extremely difficult to teach the students about new concepts which are different from the things that have been taught in conventional education. So we need more effective pre-educational methods. Teach them about creative invention method so that they are able to think in various ways to find a solution to a given problem. We also propose design education method which will help them look for problems by themselves, and find solutions by considering the whole system to which the problems belong. They will not be confined to merely designing products. Education in 'academic writing' will help them write the product instructions in an effective way. Educate them also about 'basic safety guidelines' and 'electricity safety' to make it safe for them to stay in the local community. 'Language education' will help them to communicate better with local people, and teaching 'balloon art' will help them get closer to local children.

3.3. Solve local problems

Every community we visit has some problems. We can help them find solutions. They might be experiencing the problems in their daily lives. Their way of considering a problem can be very different from ours. Even though we recognize some problems, they might not consider them problems at all. Take notice here what is more important than resolving local problems is 'making students learn through experience'. Eventually, it might happen that we might not be able to solve local problems. Or the products made through our hard work might not be permitted to be installed. Through these processes, however, students will grow and be trained.

First, identify local problems and define them. Through brainstorming, come up with an idea to deal with them. At the stage of product design, complete the drawing and make the list of the things to be purchased. Always try to be in the shoes of the user when making a product, and prepare product instructions for local residents to refer to. Through the final evaluation, look into the feasibility of installation. After that, install the product in the right place.

3.4. Be one with the community

Out visit may mean a lot to local people, regardless of where we visit. 'Engineering service' is a new concept to a lot of people, and the fact that students from different countries work together for common goals might seem quite exotic (Marybeth & William, 2006). We need to let local people know who we are and why we are there. And we definitely need cooperation from the local community during our sojourn. So it is imperative we try to become one with the local people with service-oriented mentality. A single visit cannot solve all the problems. Announce the start of the project by arranging meetings with local people and holding the welcoming dinner. Walk around the area every morning and gather further information about the community while on an independent mission. With the information you got, try to help the community through general service as well, apart from engineering-related help. Finally, hold the farewell party wishing for the successful continuation of the project in the future.

3.5. Organize ideas and share them

Every activity should start with well-formed teams. There are a lot of things to be considered in grouping students. The success of the project is not dependent on functions and proper installation of the product. Short-term successes and failures all serve the purpose of making students experience things. What's more important is experiential learning for the students: evaluating their own products, giving assessment to their members, and sharing ideas (Hatcher & Bringle, 1997). The success of the project can be discussed after a long while when the accumulated experiences from continuous yearly programs can develop into improved versions each year. Self-reflection allows the participants to look back on the past activities during the project and share experiences with peers. By holding the exhibition where the assessment of the product will be given, participating students, other students, and neighbors can have a chance to evaluate the products themselves. By consensus, team members select the best member. Every activity happening during the project should be documented in the daily journal. Daily operation of the project is checked and arranged in the general daily meeting every morning. Lastly, the final report session will facilitate conveyance of participants' experiences to many people.

4. Creativity Station 2013 in Indonesia

Tegal Mulyorejo Baru (TMB) village is located on the neighborhood of EEPIS at Surabaya, Indonesia and in close vicinity to the coast. TMB is a big village but almost people are migrant workers. Problems exist everywhere we go. Problems felt by local people and our perceived problems may be different. Participants tried to define a problem to which a solution is feasible for the duration of the project. Even finishing up the solving problem for the village by participants only is beyond our capacity, problem formulation is valued in the process of problem based learning. Things to be considered when identifying a problem were formulated as follows.

- Don't define a problem to which we have a pre-perceived solution. Undesirable problem definitions are; "Since it is hot, they need an electric fan.": or "Since it is not ventilated, they need a ventilator."
- Recommended ways include; If you see a room for children which is musty because of lack of ventilation and is not good for health, we might later discuss ideas to deal with it with team members, and one of the suggested solutions might be installing a ventilation system.
- That is to say, the ventilation system should be only one of the solutions to get rid of must in the room. Please remember that there are many possible solutions.

50 undergraduate students in third and fourth grade from Korea, Indonesia and Malaysia participated in this program and they were divided to 10 teams. One team is made up of 5 students who are 2 Indonesian, 2 Korean and 1 Malaysian. We considered individual personality of each student for building teams such as the MBTI (The Myers-Briggs Type Indicator) type and specialty. And they carried out missions of this project on seven-day six-night at TMB village and around EEPIS campus in Surabaya at Figure 3.

Each team found out the most crucial issue of TMB village and defined the problem by themselves. The main issues are rubbish problem, no air circulation, insect problem, drying up the rice residue, drying up clothes in the rainy season and drainage. Participants should have defined the most urgent problem to be dealt with of all the problems local people are experiencing. The next step is to find solutions. There are a lot of ways to look for solutions, but the most effective way might be 'brainstorming' in case of short time. Team members spontaneously talk about their ideas in the brainstorming session. For efficiency, it is a good idea to distribute sticky papers to each student to write down their ideas on. Collect the papers and put them on the wall and start from an idea which the smallest number of students shave thought of. They could consider all different perspectives ranging from general solutions to seemingly totally unrelated ones. Any idea was welcome in the process of brainstorming. The key is to select out the final idea which the most feasible is considering multiple variables (environment, manpower, budget, time, and etc.). Once they have selected the most appropriate idea amongst all the possible 'solutions', they should write it down according to the principles of 'academic writing' before they try to explain the concept.

Finally 10 teams made 10 items for engineering service and installed successfully from their own ideas. When we were there, it was a rainy season. It's difficult to dry clothes. Also there were many problems of waste disposal in there. A team, before starting the installation, should discuss the site and concrete ways of installation with the manager. Users' convenience should be considered as the top priority in the installation process. Installed items are like below and shown in Figure 4.

- 4 items were related with the trash; Spinning Trash Bin, Separation bins, Recyclable cutter and Trash compactor
- 3 items were clothes dryer; Height adjustment dryer, Vinyl house type dryer and Umbrella type dryer
- 1 item was the rice dryer
- 1 item was the temperature fan
- 1 item was the sewer cover

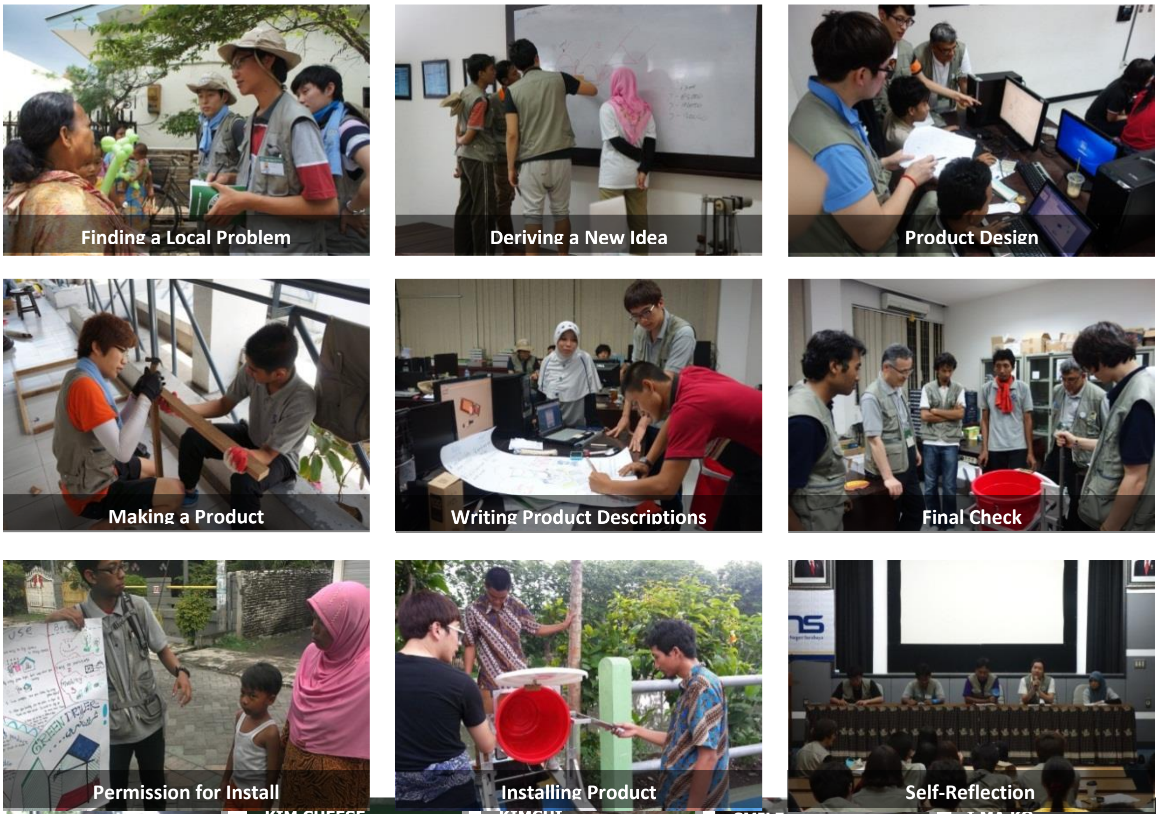

Figure 3. Field sketch of each mission

Figure 4. Installed items of Creativity Station 2013

10 managers whose they consisted of 1 Korean, 2 Malaysian and 7 Indonesian were in charge of each team project. Professors with engineering majors followed and monitored their team every time and everywhere. And checked all mission of each stages

and advised when needed. We gave also to students an opportunity to look back on the past activities and focus on themselves. Self-reflection note should cover various aspects including ability to utilize one's own skills and resources, cooperative spirits, communicative skills, self-management, analytic thinking, global capabilities, and etc. Several sentences from the student reflection are as following.

- I've got new experience and new friend, learned how to solve local issue and how to apply our capability. This program made my communication skills to improve, our engineer soul come to live and another people to care.
- This program has taught me many new things such as thinking as an engineer and thinking out of the box. I also share some knowledge with other participants. I have grown one step than before and hope this growing will keep continuing
- Throughout this program, we had many activities that packed our schedule. Every single activity was fun and had something for us to learn. I was so amazed at how wonderful the office of Creativity Station was. My impression was that this project is really established here and they organized it perfectly. We also had our first Korean language class and we were each given a Korean book to use throughout the lesson. I was again impressed that we each have a book to guide us and I did not expect this at all. I was really happy. When we checked in to Carica Homestay, the accommodation was really clean and comfortable, I really appreciated that.
- I think that the balloon art competition was a way for us to have fun and also as a tool for us to mix with the local people. It was a great activity. It was fun meeting the local people and the children were excited when they saw that we would be giving them the balloons. It also made it easier for us to speak to their mothers and ask them about local issues in the village. We enjoyed mixing with the children and taking photos with the local people. Once we had enough data for local issues we went back to campus to decide which issue we should select. We had long discussions on this.
- Product design taught me a lot about technical aspects of building a product. I learnt how to apply theory into practice. I benefitted a lot because I am from a different major. We also discussed about our budget and thought about the feasibility of our product.
- I think this program is very necessary, because of this program I can increase our knowledge, experience and make a better conversation quickly.

5. Program outcomes in Creativity Station 2013

The United States and many other countries have been introduced the accreditation for engineering education to guarantee international equivalence of their own students. The standard of equivalence includes program outcomes both major knowledge and liberal arts. Educational objectives are firstly determined by each university and college, and the accreditation system is established to achieve the learning objective. They also decide the program outcome by themselves. Individualized instruction programs focused on the personality for each student. Compared with ABET (Accreditation Board for Engineering and Technology), ABEEK (Accreditation Board for Engineering Education of Korea) has an additional program outcome, that is an ability to understanding of different cultures and cooperating internationally.

The achievements of program outcome for the whole program were analyzed by Seo (Seo et al., 2012). Recently, Korea Research Institute for Vocational Education & Training presented "BJA (Basic Job Ability) of students". Depending on BJA, the previous program outcomes are assorted into six groups. An ability to utilize resource, information and technology is matched to engineering knowledge, experiments analysis, design analysis, problem solving, and engineering tools use. Self-management capability also is matched to life-long learning and professional responsibility. An ability to think synthetically is matched to engineering impact and contemporary issues. Use the Matching table with basic job ability of students and ABEEK program outcomes in Table 2, survey results of primary program outcomes of engineering service design project can be classified.

Table 2. Matching table with basic job ability of students and ABEEK program outcomes

Notation	Basic Job Ability of Students	No	ABEEK Program Outcomes
TA	Technology appliance	1	Engineering knowledge
		2	Experiments analysis
		3	Design analysis
		4	Problem solving
		5	Engineering tools use
IS	Interpersonal skill	6	Multidisciplinary function
CS	Communication skill	7	Communication skill
SC	Self-management capability	8	Life-long learning
		11	Professional responsibility
ST	Synthetic thinking	9	Engineering impact
		10	Contemporary issues
GC	Global capability	12	International cooperative

Table 3. Program outcome in each mission

Mission	Program Outcomes

	1	2	3	4	5	6	7	8	9	10	11	12
Team Building							○					○
Teamwork Game							○					○
Morning Walk							○	○				○
Balloon Art							○	○				○
Finding Local Issues							○	○	○	○	○	○
Deriving a New Idea			○	○			○	○	○	○	○	○
Product Design	○	○	○	○	○	○	○					○
Purchasing Materials			○	○			○					○
Making a Prototype	○	○	○	○	○	○	○					○
Writing Product Descriptions	○						○					○
Writing Reflection Notes							○	○	○	○	○	○
Prototype Evaluation	○		○	○			○		○	○	○	○
Installing Products	○		○	○	○	○	○					○

Associations with Program Outcomes in each mission are depicted in Table 3 (Seo et al., 2013). The achievements of program outcome are evaluated by the survey from the participants. Some improvement opinions have been directly reflected in the planning for next program. The survey was carried out on 49 participants before they get involved and after finished the whole project at February 2013. Through surveys done before and after the project, same questions per program outcomes can be used to analysis the achievement of several missions. According to calculate the average from four questions in each program outcome, we ask 48 questions on primary program outcomes in each step. We made inquiries about grade, gender, duty and major in order to standardize sample group. From Table II, survey results of primary program outcomes of engineering service design project can be classified as the achievement data of basic job ability. In Figure 5, all achievement degrees are increased, but especially global capability (GC) and communication skill (CS) are increased more.

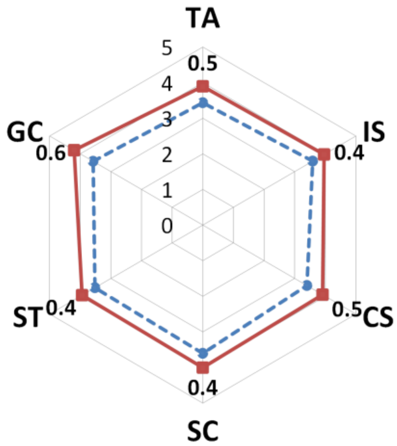

Figure 5. Improvement of basic job abilities
(Dashed line: Before project, Solid line: After project)

6. Conclusions

Innovation Center for Engineering Education at Pusan National University developed the engineering service design program which is 'Project BEE-Creativity Station' for multi-disciplinary teams of Korean, Indonesian and Malaysian students. In this paper, we introduced the concept of service learning is presented with five topics which are consist of 29 detail missions. Participants can refer to the schedule book to get information about various missions each project requires. The teaching manual provides additional explanation and will help the students understand the guidebook better. Each team found out the most crucial issue of TMB village and defined the problem by themselves. They derived several ideas and made products for solving local problems. Participants of Creativity Station 2013 satisfied this program in many points, such as service for local people using their major, improving communication skill and teamwork, making foreign friends, experience of various cultures and etc. Through surveys done before and after the project, same questions per program outcomes can be used to analysis the achievement of several missions. According to calculate the average from four questions in each program outcome, all achievement degrees are increased, especially global capability and communication skill are increased more.

References

Hatcher, J. A., & Bringle, R. G. (1997). Reflection: Bridging the gap between service and learning, *College Teaching*(pp. 153-157).

Choi, J. W.,, Seo, Y. B., & Eom, J. I. (2011). A PNU Model of Engineering Service Learning as a Multidisciplinary Design Project, *IEEE Global Engineering Education Conference*, Amman, Jordan.

Marybeth Lima & William C. Oakes (2006). Service Learning: Engineering in Your Community, *Great Lakes Press, Inc.*
Seo, Y. B., Eom, J. I., & Jeong M. J. (2012), Problem Based Learning in Engineering Service Design Program, *IEEE Global Engineering Education Conference,* Marrakech, Morocco.
Seo, Y. B., Eom, J. I., Jeong M. J., Kim, Y. E., & Lim, O. K.Lim (2013), Analysis of Program Outcomes in Project BEE – Outreach Together 2012, *IEEE Global Engineering Education Conference,* Berlin, Jermany.

Technology-enhanced Classroom Learning Community for Promoting Tertiary ICT Education Learning in Malaysia

Mohd Nihra Haruzuan Mohamad Said[a]*, Johari Hassan [b], Abdul Razak Idris [c], Megat Aman Zahiri [d], Mike Forret [e], Chris Eames [f]

[a, b, c, d] *Faculty of Education, Universiti Teknologi Malaysia, Johor Darul Ta'zim, 81310, Malaysia*
[e, f] *Centre for Science and Technology Education Research, University of Waikato, Hamilton, 3240, New Zealand*

Abstract

This paper described the processes of incorporating technology-enhanced learning community (TELC), with its aim to promote students' learning in ICT education in a Malaysian tertiary classroom. This research has drawn on data from a semester-long tertiary ICT education course with Virtual Learning Environment (Moodle) and online forum are designed as TELC by integrating online collaborative learning activities to foster students' interactions and collaboration. Data collected from questionnaires, interviews and online forum transcripts were the basis for an interpretive analysis to develop a more theoretically-based analytical framework for understanding the processes of students' interactions in TELC for learning.

Keywords: Technology-enhanced learning online learning community and tertiary ICT education

1. Introduction

Socio-cultural perspectives of learning advocate the formation of learning community through participation in the social groups that are focused on a common outcome (Harasim, 2012) in support of the development of cognitive, social and emotional aspects (Sewell & George, 2008). Although there are various types and characteristics of learning communities, a learning community is usually guided by two important elements: (a) tasks to be fulfilled by member of the community, and (b) goals to be achieved through the interactions within the community (Harasim, 2012). A key benefit of participating in learning community work is that a student has the opportunity to; learn from more knowledgeable peers, learn to take responsibility for their learning, and to develop more autonomy in their learning. The instructor's role is shifted from instructive to supportive and they act more as a facilitator or coordinator to structure and guide the overall direction for students' learning. Students, on the other hand, increasingly learn to participate and manage their own learning and involvement and provide some leadership, at times demonstrating increasing confidence and expertise as they progress from the periphery towards the centre of the knowledge community (Lave & Wenger, 1991). This is crucial, as learning is not viewed as the mere acquisition of concepts or skills but as the appropriation of the culture (or enculturation) specific to the target knowledge community (Yotam & Dani, 2012). A learning community is usually associated with an educational program or course, guided or established by a lecturer and linked to the curriculum of studies that represents formal and non-fornal learning (Harasim, 2012). The members (or students) do not participate voluntarily but are recruited by lecturer to meet particular learning objective within the framework of the knowledge community. This is consistent with the view that the development of learning in learning community is a process of transformation through people's participation, rather than an acquisition of knowledge (Lave & Wenger, 1991). Furthermore, the students' participation is constantly changing as the knowledge community is shaped by, and in turn shapes, the development of its participants.

* Corresponding Mohd Nihra Haruzuan Mohamad Said. Tel.: +0-607-553-3156
E-mail address: nihra@utm.my

2. The purpose of study

As previous researchers (e.g. Harasim, 2012; Pallof & Prat, 2005) indicate that the challenge for educators in incorporating learning within an online community environment is that the learners' interactions cannot be coerced, instead the interactions are said to be maintained by educators through facilitating learners' interactions and relationships by encouraging them to collaboratively interact with one another. Therefore, in order to inform this process, the objectives of this paper are to:

- illustrate the development of a framework for monitoring and analyzing learners' interactions within an online learning community environment; and
- provide evidence for value of learners' interactions within technology-enhanced learning community (TELC) based on findings from a semester-long tertiary course with online participation.

3. Theoretical perspectives

The constructivist learning perspectives advocates an active joint endeavour between teacher, students and their peers in constructing meaning. The philosophical view of constructivism is knowledge constructed through interactions with one another including the community and environment and the result of the interaction is not always absolute, rather it is an umbrella term representing a range of perspectives on learning, for instance, situated and active learning, learning by doing, problem-based learning, inquiry-based learning, cooperative learning, collaborative learning, personalized learning, the learning community, active participatory learning, activity and dialogical processes, anchored instruction, cognitive apprenticeship, discovery learning, and scaffolded learning (Ally, 2008; Harasim, 2012; Schunk, 2012). However, the constructivist learning theory also ignores some other important aspects potentially contributing to the success or failure of learning including the role of cultural artefacts, the nature of the learner, the nature of the environment, and their relations within a cultural contex (Gunawardena, Wilson & Nolla, 2003; Tu, 2007). As the nature of learners' interactions within an online environment are complex to understanding but critical in supporting learners' development of cognitive, social and emotional aspects, it is suggested the interaction and participation of learner in TELC can be framed as mediated, distributed, situated and goal-directed within an online learning environment (Forret, Cowie & Khoo, 2009).

3.1. Mediated action

Mediated action refers to an interaction between the individual and mediating artefacts or tools or signs, a semiotically produced cognitive tool that resulted from the interaction (Yamagata-Lynch, 2010). Wertsch (1998) argues that human action employs the cultural artefacts as meditational means to accomplish a task or objectives. The importance of the humans and the cultural tools to achieve goals are irreducible in the context of the individual's mental functioning (Wertsch, 1998). These cultural tools act as an intermediate agency between the mental processing of the individual and the object of the mental processing. A mediated action view on learning also signified Vygotsky's ideas such as mediation by tools (e.g. symbols, texts, signs, language) and its role in bridging the learner's cultural development. Vygotsky (1978) argues that every function in the learner's cultural development occurs twice: initially on the social level (between people, inter-psychological), and later, on the individual level (inside the individual, intra-psychological). According to Yamagata-Lynch (2010) individuals as learners are not passive participants waiting for "the environment to instigate a meaning-making process for them but, through their interactions, individuals make meaning of the world while they modify and create activities that trigger transformations of artefacts, tools, and people in the environment" (p.16).

3.2. Distributed cognition

The notion of distributed cognition suggests that learning is distributed across the members of a social group (Salomon, 1993) and the person-plus, the individual student, and the environment (Perkins, 1993). The cognition is located outside the individual learner's brain and occurs in the interactions among many individual learners' brains, and cultural tools (or environment). Salomon (1993) states that distribution or distributed is a term intended to mean sharing including sharing authority, language, experiences, tasks and a cultural heritage (p.111). Distributed cognition occurs within social interactions and communications of cultural activities. Salomon (1993) argues that knowledge has the potential to be off-loaded on to a device like a calculator or computer with cognitive functions placed on the machine. Cognition or knowledge is communicated into external representations in physical or virtual which embodied experience through the sensory systems and mental filters of individual learners interacting with learning artefacts, environmental elements, and other people. In the literature of computer supported collaborative learning (CSCL) and computer supported collaborative work (CSCW), distributed cognition has been considered in terms of how collaborative spaces are designed and used.

3.3. Situated activity

Viewing learning as situated within cultural activities is the central focus of the situated activity approach. Fundamentally, situated activity represents a range of perspectives on learning including situated learning (Lave & Wenger, 1991) and situated cognition (Brown, Collins & Duguid, 1989). The situated approaches view learning as situated and embedded in a system of activity, communications, culture and context. The unit of analysis involves not only the individual learner or the tools, setting and environment but also the relationship between the two (Barab & Plucker, 2002). From this perspective, separating the learner, the material to be learned, and the context in which learning occurs is impossible and irrelevant because learning and activity are irreducible into separate processes (Barab, Schatz & Scheckler, 2004). In situated learning, learners go through a kind of cognitive apprenticeship in a knowledge community within an applied learning environment of various levels of expertise where the learners move from the periphery to the centre of the practice (Lave & Wenger, 1991). In other words, the newcomer learner moves from novice to an expert through developmental phases of learning and through interacting and engaging in authentic learning works (e.g. real-world problem solving, problem-based learning, project-based learning, and creative work) within the knowledge community.

3.4. Goal-directed

A goal-directed perspective on learning emphasises the embeddedness of goals within cultural activities in accomplishing desirable learning. The notion of learning as goal-directed is seen to be highlighted in Activity Theory which refers to goal-directed actions anchored with other related activities, the goal and the motives for participating in an activity and material product that participants try to gain in an activity (Yamagata-Lynch, 2010, p.17). Kaptelinin (2005) argues that an object or goal is the reason why individuals and groups of individuals choose to participate in activity, and it is also what holds together the elements in activity (cited in Yamagata-Lynch, 2010). In an object-orientedness and goal-directed action, the individuals and groups of individuals' participation are motivated by their goals and motives which may potentially lead to the creation of new artefacts that can make the activity robust (Yamagata-Lynch, 2010). Consequently, people as human beings are normally considered to respond when "an environment consists of entities that combine all kinds of objective features, including the culturally determined ones, which, in turn, determine the way people act on these entities" (Kaptelinin, 1996, p.103). Viewing learning as goal-directed in the educational practice requires the structuring of goal-directed learning activities when teaching in the classroom. Through these goals, the students are supported in their way to attain the goals through meaningful social activities (Häkkinen et al., 2004).

4. Context for TELC

In this research, the context for the TELC intervention is the TELC group work, where students worked together on tasks for a shared outcome within and across online groups through a shared space of Virtual Learning Environment (Moodle) in an ICT education course. The TELC group work is aimed to facilitate the interdisciplinary online collaboration and interactions between students from Chemistry, Physics and Mathematics Education majors and to enhance their learning (Mohamad Said, Forret & Eames, 2010). Previous researchers suggested that the interactions and experiences gained from the online collaborative activities can be considered as 'lived spaces' or equal to a physical classroom, which can facilitate both the opportunities and means for acting (Harasim, 2012, p. 98). Furthermore, through TELC, students can construct knowledge and negotiate meaning through interactions and collaboration; they are not merely transmitting information or receiving communications (Harasim, 2012; Mohamad Said, 2011). The content for discourse and interactions in TELC are also generated by students through the affordances of TELC group discussion applications (e.g. forums) organized by the lecturer. In this way, the students could enter and navigate the TELC discussions at their convenience, to read and contribute to the group work.

5. Research design

The qualitative classroom case study approach (Merriam, 2009; Yin, 2009) in line with the work of Tellis (1997) and Bélanger (2006) was employed and comprised four important phases as elaborated below:

5.1. Phase 1: Defining and designing the study

Establishing the need analysis for TELC including: identifying appropriate subject or course with issue or problem in learning and the potential concerns and challenges of TELC. It also included critical reviews of literature on the nature of TELC interactions. The information obtain in this phase was used as baseline data for constructing the questionnaires, interviews (students and lecturers) and online transcripts (for evaluation e.g. online journal). All instruments were piloted prior to actual study.

5.2. Phase 2: Conduct case study

The second phase of this study was by conducting the case study through preparing and collecting the data: both quantitative and qualitative data. Quantitative data involved the distribution of online questionnaires at the beginning and at the end of the research, while qualitative data was obtained through students' and lecturers' interviews, forum and online transcripts. Prior to the data collection, the researcher sent a formal letter to the Dean of the Faculty of Education, Universiti Teknologi Malaysia (UTM) requesting his permission to conduct the research. The formal letter consists of an information sheet describing the research in detail and seeking permission to approach targeted participants at the Faculty of Education. The students' and lecturers' informed consents were also collected at the beginning of the course. Data generation involved in-depth interviews and analysed using grounded theory technique – constant comparison approach and content analysis based on participative, interactive, social, and cognitive dimensions.

5.3. Phase 3: Performing data analysis

The third phase of the study was by analysing the case study evidences or data. The data generated during TELC intervention was analysed quantitatively and qualitatively. Quantitative analysis was performed on quantitative data collected from online questionnaires, together with online data based on the online transcripts. The online transcripts was analysed using content analysis techniques based on participative, interactive, social, and cognitive dimensions (Henri, 1992; Hara, Bonk & Angeli, 2000; Lipponen, et al., 2003; Gerbic & Stacey, 2005; Pozzi, et al., 2007). This study used modified Henri's (1992) analytical instrument in order to analyse students' interactions within TELC. Based on the literature, Henri's (1992) analytical instrument is the most cited instrument in online learning research and is often used as a starting point in many Computer Supported Collaborative Learning (CSCL) studies (Wever, et al., 2006, p.11). It also can be considered as pioneering work and has been the base for subsequent research of online learning environment (Wever, et al., 2006).

In order to safeguard credibility and to validate the coding procedures of the modified categories from Henri's (1992) model, intra-rater and inter-rater coding were employed. Intra-rater was conducted by the researcher as 'coder agreeing with his self (coding) over time' (Wever, et al., 2006). This was done by running the coding multiple times before reaching coding stability. The inter-rater reliability (the ability of multiple and distinct groups of researchers to apply the coding scheme reliably) was conducted between two independent coders agreeing with each other (Wever, et al., 2006). Guidelines for coding were formulated stating clearly what comprises a unit, and descriptions of all categories. Two graduate Malaysian researchers were asked to help with the coding with the guidelines and instructions were introduced to them. A one-hour training session was held during which these guidelines explain. After that, one transcript was randomly selected (altogether totalling approximately 10% of online transcripts) and coded separately by the two coders and they then compared their results. The result across all categories reached a Cohen's Kappa value of 0.81 compared with individual categories such as interactive with 0.84, social with 0.74, cognitive with 0.71 and information processing (surface and deep) with 0.72. According to previous researchers (Rourke, et al., 2001; Neuendorf, 2002; Wever, et al., 2006) a value above 0.75 (sometimes 0.80) is considered to be excellent agreement beyond chance; a value below 0.40 indicates poor agreement beyond chance; and values from 0.75 to 0.40, represent good to fair agreement beyond chance. This study's yielded 0.81 Cohen's Kappa value for the consistency of inter-raters' agreement which can be considered highly reliable (Wever, et al., 2006).

Qualitative analysis was conducted on the data collected from interviews with students. The verified interview transcripts by participants were analysed constant comparative method at two levels: within-case analysis and cross-case analysis, in order to generate meaningful qualitative themes (Maykut & Morehouse, 1994; Huberman & Miles, 2002; Merriam, 2009). In this method, each individual group of transcript was studied and emerging themes from the data will be coded and compiled for each group. The emerging themes were then compared across groups and subsequently categorise into similar units of meaning. The categories were continually refined, changed, merged or removed and grouped accordingly. Cross-case analysis within and between groups were conducted to explore relationships and patterns that emerged from the interactions within each individual group case.

5.4. Phase 4: Reporting the findings

The final phase of this study research is the stage of reporting the findings of the study. Creswell (2008) suggests that the report of a study that include both quantitative and qualitative methods depending on whether the strategy for conducting the study was sequential or concurrent. A sequential study is one where qualitative and quantitative phases are conducted separately in the research and a concurrent study is one in which the quantitative and qualitative methods are applied concurrently, as was the case of this study. Therefore, the report of the findings in this study is structured to answer the research questions using both analysis and interpretation of quantitative and qualitative data. This was the structure adopted for reporting the findings for this study.

6. Online interaction dimensions in TELC

Previous research in the literature suggests that monitoring and facilitation of online learning environment can be initiated by providing learners with appropriate support by adjusting the TELC activities based on learner's interaction dimensions (Henri, 1992; Pozzi, et al., 2007). For this study, the researcher has established four developed dimensions with added categories are elaborated upon as follows:

- The participative dimension categories were developed to include categories based on the level of participation determined through students' number of postings and viewings (Mohamad Said, Forret & Eames, 2011). These categories were based on two types of indicator of students' active and passive participation. Active participation was measured through the number of postings students made in the online discussion while passive participation measured the frequency of students viewing particular posts in the online discussion.
- The interactive dimension categories were developed to include categories based on thematic units referring to physical aspects of the online communication such as the frequency of explicit and implicit (or collaborative) interactions, and independent (or cooperative) statements (Mohamad Said, Forret & Eames, 2011). The research also considered the

qualitative aspects of students' interactions by identifying students' ways of interacting online (such as used in this research: providing information, sharing views, sharing experiences, agreeing and disagreeing, posing questions, suggesting new ideas, giving feedback, and clarifying ideas) during the intervention activities (Pozzi et al., 2007).

- The social dimension categories were developed to include categories based on thematic units characterized by affection and cohesiveness exhibited during communication in online discussions (Mohamad Said, Forret & Eames, 2011). Thematic units characterized by affection include the use of emotional expressions (such as used in this research: emotion icons or emoticons) and thematic units characterized by cohesiveness including the use of social cues (such as used in this research: greetings, salutations, concern, encouragement, apology, jokes and humour, and thanking).
- The cognitive dimension categories were developed to include categories based on cognitive presence revealed by thematic units referring to (1) revelation (renamed as clarification) that is, recognizing a problem, explaining or presenting a point of view; (2) exploration (renamed as judgment) that is, expressing agreement or disagreement, argumentation, exploring or negotiating; (3) integration (renamed as inference) that is connecting ideas, making syntheses and creating solutions; (4) resolution (renamed as strategies) that is, reflecting on real-life application suggestions or references to real-life solutions (Mohamad Said, Forret & Eames, 2011).
- Additionally, the information processing (e.g. surface and deep) categories were developed to include categories based on thematic units referring to (1) surface learning that includes reproducing an approach (not wanting to understand the issue or finish with minimum of effort); or staying inside course boundaries (repetition of what is being discussed or required); or an unthinking approach (jumps to a conclusion with an uncritical acceptance of ideas); or fear of failure (focus on negative aspects of the coursework); or extrinsic motivation (more concerned about passing the assessment than learning); and (2) deep learning includes looking for meaning (focus on what is signified, asking questions to understand new information); or relating ideas (relating ideas to previous information or knowledge to generate new ideas); or using evidence (finding alternative ways of interpreting information or justifying with an example); or intrinsic motivation (desiring to learn more about the topics) (Gerbic & Stacey, 2005; Mohamad Said, Forret & Eames, 2011)

7. Synthesizing ideas and putting the framework of TELC in action

The ideas from the literature and learner interaction dimensions were integrated into a framework as shown in table 1. Generally, the students' performance is firstly monitored through the participative dimension, which included students' participation and involvement in TELC discussions. In the participative dimension, the TELC group work is facilitated with authentic and relevant tasks that situated the learning in order to accomplish a shared goal. Secondly, the interactive dimension facilitated students' participation in TELC through interactions with their peers and other students. Through these interactions the students could communicate, interact and collaborate with their peers and others in order to access the knowledge, understanding and expertise distributed across the online groups. Thirdly, the social dimension facilitated students' social interactions between their peers and other students. The facilitation of the social dimension used a variety of social cues and emotional expressions in the online posts. Finally, the cognitive dimension facilitated the students' interactions for knowledge construction through their interactions in the TELC discussions.

Table 1. Facilitating students' learning in TELC

Dimension	Facilitation of TELC	TELC Tools
Participative Participation in TELC is situated and goal-directed.	• Introduction of TELC by the lecturer via Moodle and self-introductions by students • TELC tasks (online groups): o Introduction to the case or problem for discussion by posting an overview of it o All students (Chemistry, Physics and Mathematics) 'read' the case or problem and identify the learning objectives or goals o Students discuss the learning objectives and problems o Students apply information gained within an online group to inter-group discussions o Students discuss solutions and reach a shared understanding o Students reflect and improve on their group's problem solution	• Course and general online activities (e.g. course content, links, resources, general discussion spaces) that invite active participation • TELC activities that are authentic, relevant and specific to the Malaysian T&L context that accomplishes particular goals • TELC tasks outlined and discussion space for online groups

Interactive Participation in TELC is an interactive process through interacting with students and others.	• Facilitating the TELC via Moodle: o lecturer as a moderator to encourage active participation from the students o Check and monitor the flow of students' activities (recorded by Moodle) o Check and monitor the flow of the TELC discussions (recorded by Moodle) o Encourage inputs from group if participation is low o Encourage cross-references for other students' information or contributions	• Course and general online activities, TELC activities within online groups and inter-groups • Cross-references of students' messages and consideration of other students' contributions
Social Participation in TELC is mediated through social interaction between students and others.	• Facilitating the TELC discussions (social) via Moodle: o Check and monitor the discussion and respond appropriately on the subject o Encourage the use of good online communication (or Net-Etiquette) o Encourage students to use an informal communication tone and expression, and students' names in the discussion	• Online socialization using social comment characters or emotion icons • Welcome, support and encouragement within online groups and inter-groups • The use of good online communication ethics (or Net-Etiquette)
Cognitive Participation in TELC is distributed through interaction between students and others.	• Facilitating the TELC discussions (cognitive) via Moodle: o Lecturer as a moderator to motivate students to contribute substantively in TELC discussions o Check and monitor the discussion and keep the discussion focused and progressing o Encourage students to create different perspectives on the discussed topic by contributing new information, negotiating solutions and justifications o Remind students to cite all quotations, references and sources o Remind students to continuously reflect on problem solutions and make improvements	• TELC discussion guides • The use of good online communication ethics (or Net-Etiquette)

8. Evidence for value of learners' interactions in TELC

The evidence of TELC value were marked as a cognitive transformation through groups' developing understanding and gaining expertise, as social transformation through groups developing joint commitment and responsibilities, and emotional transformation through groups developing confidence, attitude and satisfaction. Evidence of interest comes from online transcripts and interviews.

8.1. Cognitive transformation: Developing Understanding and Gaining Expertise

All groups' responses from the online group discussions in the course indicated that students had developed understanding and gained knowledge and expertise about Authoring Language, computer and ICT. All nine groups reported becoming more knowledgeable about authoring software, computer and ICT, as reported by Brian from Group 9:

> As a learner before I have entered this course, I have never heard of Authorware, let alone the processes of building interactive presentations. My weakness is that I am not highly creative when it comes to building interactive presentations. After entering this course, I have learnt not only about building an interactive presentation but also including other media, display, and so on. These are all available in this course and I am glad that I have participated in it. (Brian, Group 9)

Six groups highlighted the value of participating in the course in helping them improve their computer-related knowledge, as they responded in their online group journal entries. Ain from Group 5 reported:

> I felt that my involvement in this course had improved my computer knowledge, in a way that I know more about computers, particularly about authoring and web authoring. Before entering this course I didn't have any knowledge about Authorware, and now I would like to learn more about it. (Ain, Group 5)

Meanwhile, data from interviews corroborated findings from the analysis of online discussion transcripts and revealed a majority of students' mentions about cognitive skills and abilities (more than 42 per cent) were focused on clarification skills, indicating students developing and gaining an understanding of the Authoring Language as well as computers and ICT in general. This also indicated how students participating in the course gained expertise and knowledge in Authoring Language, computers and ICT - from that of a novice at the beginning of the course towards becoming more expert-like at the end of the semester.

8.2. Social transformation: Developing Mutual Responsibilities and Relationships

Students' interactions as a result of participating in online group collaborative learning in the course fostered social outcomes with students changing from competitive and individualistic viewing of learning towards appreciating others' contributions at the end of the course. Ruhi from Group 6 reported how she appreciated her increasing responsibilities for participation in the course:

> One of our responsibilities is to remind them and care about others participating in discussions because when we discuss we need feedback, so, by reminding other students to participate in the online discussion, we can get responses for those who are online. (Ruhi, Group 6)

Hami from Group 9 added that through sharing contrasting ideas and disagreement in the discussion he was able to see valuable ideas for learning and develop a mutual relationship with other students in the course. Hami reported:

> When I disagree with someone's point, it doesn't mean I'm fooling around, but I want to identify what are the points. I want to see the points and the explanation and also the supportive ideas. If there are points that we can support and argue with our ideas, we are free to point out our view. We are university students, so critics and compliments are a normal thing that we should accept. This is my effort to build partial agreement [mutual relationship] in the discussion so that we can expand the discussion with new ideas. (Hami, Group 9)

Meanwhile, data from online transcripts and interviews corroborates findings indicating students' developing roles and responsibilities towards working together. This also described how students developed mutual responsibilities and relationships in online discussions while learning about Authoring Language, computer and ICT which were evident through their reports of their increasing mutual responsibilities, relationships and commitment within their group and across other groups.

8.3. Emotional transformation: Developing Confidence and User Satisfaction

From the interviews and online discussions set up at the end of the course, all groups commented on how much they had gained confidence through discussion and learning about Authoring Language in particular and computers in general. Ruhi from Group 6 reported:

> We have to think critically on how to do the task together because when the lecturer asks us to discuss it in the classroom, we will feel very shy to do it, but the case is different when we do it in eLearning where we feel more confident to do [discuss] it. (Ruhi, Group 6)

Seven groups reported that their participation in the course had changed their attitudes towards learning about Authoring Language, computer and ICT. Busyra from Group 7 reported:

> Before entering this course, I was a person who knew nothing about Authorware but after entering this course, I now know what is Authorware and my participation in discussions through eLearning somehow has changed my attitude to be involved more in eLearning and learn more about computer subjects especially this course where we have to participate in an interactive eLearning forum. (Busyra, Group 7)

In addition, six groups responded in the online group discussions that they would recommend the course to other students. All students generally agreed that they enjoyed learning online in the course and were satisfied with their group work outcomes. This described how students reported that they developed their confidence and satisfaction by participating in the course.

9. Conclusion

This paper has highlighted several useful ideas of learning from the socio-cultural perspective in guiding and developing the educational teaching and learning practice. The emphasis of learning with the consideration on social, cultural and historical contexts mediated by cultural artefacts provides a useful way of analysing the learning context for this research. In this way, this study is able to characterize the process of designing and supporting the incorporation of TELC for learning tertiary ICT education in a Malaysian classroom. The TELC activities in which learning is embedded serve as the core of this research. From these TELC activities, the researcher is able to analyze learning processes and outcomes for the purpose of designing instruction and facilitation. Rather than focusing on knowledge state, the research is focused on the activity in which students are engaged. Articulating each of concepts and approaches that are associated with TELC activity and their dynamic interrelationships is important, because the richer the context and the more embedded the conscious actions are in the context, the more meaning learners could construct both for the activity and the learning. Designing TELC for collaboration and interaction in the classroom is a complex activity that can be difficult to characterize and describe to others because of its dynamic social nature. The investigation would therefore focus on how the incorporation of TELC in a tertiary classroom might create new tools and forms of activity based on the students' collaborative endeavors that would be transformed into learning outcomes.

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References

Ally, M. (2008). Foundations of educational theory for online learning. In T. Anderson (Ed.), *The theory and practice of online learning*. Edmonton, Canada: Athabasca University.

Barab, S., & Duffy, T. (2000). From practice fields to communities of practice. In D. Jonassen & S. M. Land (Eds.), *Theoretical foundations of learning environments* (pp. 25–56). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Barab, & Plucker, J. A. (2002). Smart people or smart contexts? Cognition, ability, and talent development in an age of situated approaches to knowing and learning. *Educational Psychologist*, 37(3), 165-182.

Barab, Schatz, S., & Scheckler, R. (2004). Using Activity Theory to Conceptualize Online Community and Using Online Community to Conceptualize Activity Theory. *Mind, Culture, and Activity*, 11(1), 25 - 47.

Bélanger, M. (2006). *A case study of online collaborative learning for union staff in developing countries.* Simon Fraser University, Canada

Boer, N., van Baalen, P. J., & Kumar, K. (2002). *An activity theory approach for studying the situatedness of knowledge sharing*. Paper presented Paper presented at the Proceedings of the 35th Hawaii International Conference on System Sciences, Hawaii.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32-42.

Cole, M. (1998). Can Cultural Psychology Help Us Think About Diversity? *Mind, Culture, and Activity*, 5(4), 291-304.

Cole, M., & Engeström, Y. (1993). A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 1-46). New York: Cambridge University Press.

Creswell, J. W. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle Creek, NJ: Pearson Education.

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptulization. *Education and Work*, 14(1), 133-156.

Gerbic, P., & Stacey, E. (2005). A purposive approach to content analysis: *Designing analytical frameworks. Internet and Higher Education*, 8(1), 45-49.

Gunawardena, C. N., Wilson, P. L., & Nolla, A. C. (2003). Culture and online education. In M. G. Moore & W. G. Anderson (Eds.), *Handbook of Distance Education* (pp. 753-776). Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.

Forret, Cowie & Khoo (2009). Developing an online learning community: A model for enhancing lecturer and student learning experiences. In *Same places, different spaces. Proceedings ascilite Auckland 2009*. http

Häkkinen, P., Arvaja, M., & Mäkitalo, K. (2004). Prerequisites for CSCL: Research approaches, methodological challenges and pedagogical development. In K. Littleton, D. Faulkner & D. Miell (Eds.), *Learning to Collaborate and Collaborating to Learn* (pp. 163-177). New York: Nova Science.

Harasim, L. (2002). What makes online learning communities successful? The role of collaborative learning in social and intellectual development. Paper presented at the Current Perspectives *in Applied Information Technologies: Distance Education and Distributed Learning,* Greenwich, CT.

Harasim, L. (2012). *Learning Theory and Online Technologies* (First ed.). New York: Taylor and Francis Group.

Hara, N., Bonk, C., & Angeli, C. (2000). Content analysis of online discussion in an applied educational psychology course. *Instructional Science, 28*(2), 115-152.

Henri, F. (1992). Computer conferencing and content analysis. In Kaye, A. R. (Ed.), *Collaborative leaning through computer conferencing,* New York: Springer, 115–136.

Huberman, A. M., & Miles, M. B. (2002). The qualitative researcher's companion. California: Sage Publications, Inc.

Kaptelinin, V. (2005). The object of activity: Making sense of the sense-maker. *Mind, Culture and Activity,* 12(1), 4-18.

Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.

Lipponen, L., Rahikainen, M., Lallimo, J., & Hakkarainen, K. (2003). Patterns of participation and discourse in elementary students' computer-supported collaborative learning. *Learning and Instruction*, 13(5), 487-509.

Maykut, P., & Morehouse, R. (1994). Beginning qualitative research: A philosophic and practical guide. London: Falmer Press

Merriam, S. (2009). Qualitative Research: A Guide to Design and Implementation. San Francisco: Jossey-Bass.

Mohamad Said, M. N. H.,, Forret, M. & Eames, C. (2011). The Nature and Characteristics of Online Group Learning in Malaysian Tertiary Classroom. *1st Malaysian Research Conference*, 17 December 2011, Auckland New Zealand.

Mohamad Said, M. N. H., (2011). The Design and Implementation of an Online Collaborative Learning in Malaysian Tertiary Classroom. *Proceedings of International Conference on Education and New Learning Technologies.* Barcelona, Spain, 5487-5492. ISBN 978-84-615-0441-1

Mohamad Said, M. N. H.,, Forret, M. & Eames, C. (2010). An Online Group for Collaborative Learning in Malaysian Pre-Service Teachers Programme. *Proceedings of International Conference of Education, Research and Innovation.* Madrid, Spain, 1719-1729. ISBN 978-84-614-2439-9

Mohamad Said, M. N. H.,, Forret, M. & Eames, C. (2010). Malaysian Undergraduate Pre-Service Teachers' Perceptions of Learning Online Through The Implementation of an Online Collaborative Learning Environment. *Proceedings of Globalization and Localization in Computer-Assisted Language Learning*. Kota Kinabalu, Sabah.

Ministry of Education (2012). Preliminary report Malaysia blueprint 2013-2025. Ministry of Education, Malaysia. Retrieved December 26, 2012 http://www.moe.gov.my/userfiles/file/PPP/Preliminary-Blueprint-Eng.pdf

Neuendorf, K. (2002). The content analysis guidebook. Thousand Oaks, CA: Sage publications

Pozzi, F., Manca, S., Persico, D., & Sarti, L. (2007). A general framework for tracking and analysing learning processes in computer-supported collaborative learning environments. Innovations in Education and Teaching *International*, 44(2), 169-179.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Assessing social presence in screen text-based computer conferencing. *Journal of Distance Education*. *14*(2), 50-71.

Salomon. (1993). No distribution without individual's cognition: a dynamic interactional view. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations*. New York: Cambridge University Press.

Sawyer, R. K. (2006). Analyzing collaborative discourse. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (pp. 187-204). New York: Cambridge University Press.

Schunk, D. H. (2012). *Learning Theories: An Educational Perspective* (6th ed.). Boston, MA: Ally & Bacon.

Sewell, A., & George, A. S. (2008). The classroom as a community of learners. In C. McGee & D. Fraser (Eds.), *The professional practice of teaching* (3 ed., pp. 204-220). Melbourne: Cengage.

Tellis, W. (1997). Introduction to case study. *The Qualitative Report. 3*(2).

Tu, C. H. (2007). Online socio-cultural learning. *International Journal of Continuing Engineering Education and Lifelong Learning*, 17(2), 99-120.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: harvard University Press.

Wertsch, J. V. (1998*). Mind as action*. New York and Oxford: Oxford University Press.

Wever, B. D., Schellens, T., Valcke, M. & Van Keer, H. (2006). Content analysis schemes to analyse transcripts of online asynchronous discussion groups: A review. *Computers & Education*, 46 (2006), 6-28.

Yamagata-Lynch, L. C. (2010). *Activity systems analysis methods: Understanding complex learning environments*. New York: Springer.

Yotam, H., & Dani, B., (2012). *Enculturation in Action:Developing Understanding about Technology-Enhanced Classroom Learning Communities*. Proceedings of the Chais conference on instructional technologies research 2012: Learning in the technological era. Y. Eshet-Alkalai, A. Caspi, S. Eden, N. Geri, Y. Yair, Y. Kalman (Eds.), Raanana: The Open University of Israel.

Yin, R. K. (2009). *Case study research: Design and methods* (4 ed.). California: Sage Publications, Inc.

Applying Constructionism and Problem Based Learning for Developing Dynamic Educational Material for Mathematics At Undergraduate University Level

Evangelia Triantafyllou* and Olga Timcenko

Dept. of Media Technology, Aalborg University Copenhagen, A.C. Meyers Vaenge 15, DK-2450 Copenhagen SV, Denmark

Abstract

As a result of changes in society and education, assumptions about the knowledge of entrants to university have become obsolete. One area in which this seems to be true is mathematics. This paper presents our research aiming at tackling with this problem by developing digital educational material for mathematics education, which will be student-driven, dynamic, and multimodal. Our approach will be supported by the theories of Constructionism and PBL. The impact of its use will be evaluated in university settings. It is expected that the evaluation will demonstrate an improvement in student engagement and understanding and consequently in student performance.

Keywords: Mathematics, Teaching and Learning, Problem Based Learning, Constructionism, Dynamic;

*"In every department of physical science there is only so much science, properly so-called, as there is mathematics." –
Immanuel Kant*

1. Introduction

The social and political dimension of mathematics education is generally acknowledged (Valero & Zevenbergen, 2004). Moreover, the importance of mathematics education to other educations, technical and non-technical, is indisputable. In some of these educations (e.g. engineering, media technology, biology), mathematics is not considered as a core subject, but it is still very essential for other core subjects. In this case, mathematics provide a kind of "toolset", which is indispensable in order to deal with challenges of core subjects.

Despite its importance, performance of many undergraduate university students in mathematics education is poor (Timcenko, 2009; Mustoe, 2001; Bialek & Botstein, 2004; Brent, 2004). Various causes of poor performance in undergraduate mathematics are identified in literature (Kessel & Linn, 1996). One of them is the lack of necessary background in the subject, which is deteriorated by the fact that over the last years an increased number of students are taking time out from studies after completing high school - often referred to as a "gap year" (Martin, 2010). A gap year makes the transition from high school to higher education harder and aggregates the so-called "transition problems". Moreover, wider participation in higher education has brought students with very different backgrounds to university classes, transforming them to a really heterogeneous group of people. Finally, changes in the specification of qualifications for high school students have also made traditional assumptions about mathematics knowledge of entrants to university courses obsolete (Kitchen, 1999; Kagesten, 1999; Greene & Foster, 2003).

Poor performance in mathematics has been recognized as one of the main causes of dropout at university level (Akinsola, & Tella, 2007). Difficulties in the exposition and development of mathematical ideas create difficulties in performing well in core subjects and thus developing a sense of general failure in undergraduates. Moreover, performing poor in mathematics lowers self-esteem and increases the anxiety level of students, making them more prone to drop out of university (Bennett, 2003).

This paper presents our ongoing research aiming at tackling with the problem of poor performance in mathematics by developing digital educational material for undergraduate university students. We are particularly interested in undergraduate university studies where mathematics is not a core subject, but it is fundamental for coping with core subjects. We focus on developing dynamic and multimodal material for mathematics teaching and learning, where the level of interaction and the way to present knowledge will be adjusted to student's cognitive ability. This digital material will be used according to a teaching and learning method combining constructionism (Papert & Harel, 1991) and Problem Based Learning (PBL) (Boud, 1998). In order to improve the design of the proposed approach, we are conducting exploratory research, by following a group of students during their mathematics courses. This kind of research will also enable us to better identify students' deficiencies in mathematics.

* Corresponding Author Tel.: +45-9940-2082
E-mail address: evt@create.aau.dk

Finally, we are currently conducting focus groups with students and interviews with teachers in order to evaluate the effect of our approach on teaching and learning of mathematics at undergraduate university level.

2. Methods

Our research is based on the principle that the development of tools for mathematics education is strengthened in several ways when based on a theoretical perspective. Adopting a theory in teaching or learning of mathematics should be part of an attempt to understand how mathematics can be taught and learned and what an educational tool can do to help in this process. It is not assumed that a theory is a statement of truth. Rather, a theory is used to provide explanations of phenomena that are observed in teachers who are trying to communicate their knowledge in mathematics or in students who are trying to construct their understandings of mathematical concepts and to suggest directions for pedagogy that can help in these processes.

2.1. The Theory of Constructionism

The theory of constructionism is inspired by the constructivist theory that individual learners construct mental models to understand the world around them. According to the principles of constructivism, learning environments should support multiple perspectives or interpretations of reality, knowledge construction, context-rich, experience-based activities (von Gesersfeld, 1991; Dubinsky & McDonald, 2001). However, constructionism holds that learning can happen most effectively when people are also active in making tangible objects in the real world. In this sense, constructionism is connected with experiential learning, and builds on Piaget's epistemological theory of constructivism (Wadsworth, 1996).

Papert defined constructionism in (Papert, 1986) as follows: "*The word constructionism is a mnemonic for two aspects of the theory of science education underlying this project. From constructivist theories of psychology we take a view of learning as a reconstruction rather than as a transmission of knowledge. Then we extend the idea of manipulative materials to the idea that learning is most effective when part of an activity the learner experiences as constructing a meaningful product*."

Constructionism has been primarily used in science and mathematics education (Papert, 1980). In order to support the constructionist approach to teaching and learning, a number of programming languages have been created (e.g. Logo) (Harel, 1991). Moreover, because of its nature it has been combined with digital technologies in order to implement interactive educational methods (Kafai & Resnick, 1996; Laborde, et al, 2006).

2.2. Problem Based Learning (PBL)

PBL is a student-centered pedagogy in which students learn through the experience of problem solving (Kolmos, Fink, & Krogh, 2004). Learning begins with a problem to be solved, posed in such a way that students need to gain new knowledge before they can solve the problem, and thereby learning both thinking strategies and domain knowledge. The goals of PBL are to help the students develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation (Hmelo-Silver, 2004).

PBL supports group work. Working in groups, students identify what they already know, what they need to know, and how and where to access new information that may lead to resolution of the problem. This procedure enhances content knowledge while simultaneously fosters the development of communication, problem-solving, critical thinking, collaboration, and self-directed learning skills. PBL may position students in a simulated real world working and professional context which involves policy, process, and ethical problems that will need to be understood and resolved to some outcome. By working through a combination of learning strategies to discover the nature of a problem, understanding the constraints and options to its resolution, defining the input variables, and understanding the viewpoints involved, students learn to negotiate the complex sociological nature of the problem and how competing resolutions may inform decision-making.

PBL represents also a paradigm shift from traditional classroom/lecture teaching. The role of the instructor in PBL (known as the tutor) is to facilitate learning by supporting, guiding, and monitoring the learning process. The tutor must build students' confidence to take on the problem, and encourage the students, while also stretching their understanding. Therefore, the role of the teacher is to guide and challenge the learning process rather than strictly provide knowledge.

PBL was first introduced in the medical school program at McMaster University in Hamilton, Ontario, Canada in the late 1960s (Neville, 2009). Since then various universities and other educational institutes have adopted PBL as a model of teaching and learning. In Aalborg University, Denmark, since its establishment in 1974, all university programs have been based on PBL, also referred to as “PBL - The Aalborg model” (Kjærsdam & Enemark, 1994). The PBL - Aalborg Model has become both nationally and internationally recognized and a trademark for Aalborg University.

2.3. Combining Constructionism with PBL

Our efforts in developing educational material for mathematics take place in a PBL context, namely in the Media Technology program at Aalborg University Copenhagen. The Media Technology program is structured in modules and organized as a problem-based study. A module is a program element or a group of program elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods. The program is based on a combination of academic, problem-oriented and interdisciplinary approaches and organized based on work and evaluation methods that combine skills and reflection, such as: lectures, classroom instruction, project work, workshops, exercises (individually and in groups), teacher feedback, reflection.

Mathematics courses in our department are conducted in the form of lectures, which are followed by exercise sessions in groups. The lectures are given by a professor, who follows a transmission teaching model and uses slides projected on the wall for communicating the content of the curriculum. After these lectures, the students have to work in groups in hand-in assignments, based on the notion of PBL group work. The assignments are typical math exercises that are solved by hand. In some cases (e.g. numerical integration, linear algebra), students are asked to hand in a solution in a computer program (i.e. Matlab), along with the by-hand solution. During the exercise time, there are two teaching assistants, who support the students during this process but only when the students ask for it. In order to complete successfully the course, the students have to pass an individual written examination.

Our current research effort focuses on building educational material for transforming assignments for mathematics education in a PBL environment at Media Technology, according to the constructionism stance. Constructionist learning involves students drawing their own conclusions through creative experimentation and the making of social objects. Therefore, we intent to introduce new learning activities, where students can experiment with pre-made digital mathematical visualizations but also are asked to create their own in order to solve course assignments. An important aspect of our research is therefore the combination of PBL group work, where students are considered to be active agents who engage in social knowledge construction, with constructionist activities, where students are building mathematical concepts through development of computer applications.

The combination of constructionism and PBL has resulted in a framework for the use and concrete scope of the proposed material for mathematics teaching and learning. According to this framework, our approach has the following characteristics:

- A part of our educational material presents fundamental mathematical concepts relative to the curriculum at hand in a dynamic way. This material will provide students with opportunities to develop visualization skills, and to explore mathematical concepts.
- A part of our educational material presents partially the solution to mathematical problems and requires the learners (students) to act in order to complete it. According to the principles of constructionism, in this case the students are supported in order to feel that they have ownership of the overall problem.
- Following the PBL approach, the learning activities of the proposed material are related to a larger task. This allows the students to see the connection between activities and thus discover the purpose of their learning.
- The tasks included in our learning activities are in line with students' cognitive ability. In order to achieve this we are currently conducting exploratory research, as it was aforementioned. As constructionism suggests, we aim at increasing the students' self-esteem and making learning valuable.
- Our approach realizes a dynamic educational method by allowing and encouraging the students to test ideas against different views in different contexts. This has been proved to enhance student performance and engagement (Borman & Sleigh, 2011). Students are also encouraged to obtain solutions to self-selected problems, by creating mathematical models and investigating mathematical relations dynamically. This procedure has been proved to help students gaining a deeper insight (Naftaliev & Yerushalmy, 2011).
- The suggested educational material is also multimodal supporting different modes of interaction with its user (teachers and students). We employ auditory-visual interaction between the educational material and its users.
- The proposed material will be used by teachers and it will enable them to implement interactive teaching. A part of this material will be also used by student groups during exercise time.

This framework serves a set of concrete requirements in our design of digital technologies for mathematics education.

2.4. Design

Our research aims at developing dynamic and multimodal digital educational material, which will support teaching and learning of mathematics at undergraduate university level. We are mainly interested in undergraduate university studies where mathematics is not a core subject, but it is very fundamental for performing well in core subjects of the study. For such an approach to be successive, it is important that it takes into account undergraduates' actual deficiencies in mathematics. Therefore, one of our goals is to gain familiarity with the actual background of undergraduates in mathematics and acquire significant insight into their attitude towards mathematics. Furthermore, taking into account the PBL method, we seek information on how students get along in their groups during mathematics problem solving, what meanings they give to their actions, and what issues concern them. We are also interested in investigating social phenomena without explicit expectations.

In order to achieve the aforementioned goals, we are currently conducting exploratory research. Exploratory research is flexible and can address research questions of all types. It will enable us to formulate the requirements framework during the design of the proposed educational material. This framework is needed in order to define the best research design but also the content of our material in relation to general topics of mathematics undergraduate university education. With the purpose of gathering exploratory data, we decided to investigate how the "Mathematics for Multimedia Applications" course is taught for Media Technology students, and observe groups of students taking this course. Media Technology is a study that fits perfectly to our statement of focusing on studies where mathematics is crucial for mastering core subjects (e.g. “Computer Graphics Programming and Rendering”, “Description of Dynamical Input and Output Media Applications”).

The “Mathematics for Multimedia Applications” course is given during the second (spring) semester and introduces mathematics needed for media technology applications. More specifically the course covers basic elements of Calculus, Trigonometry, Geometry, and Algebra. At the beginning of the semester we asked for volunteer student groups for collaboration. One group composed of seven students, three females and four males, responded to our request. We are currently conducting overt, direct observations of ten lectures and of ten exercise sessions. These observations span the whole semester. During these observations we are gathering data on individual behaviors of students and teachers (the professor and teaching assistants), interactions between them, and how digital technologies could contribute in improving teaching and learning for this course. These findings will be incorporated in the future steps of our design.

3. Implementation

The field of mathematics has benefited from technology throughout its history. Mathematical tools have advanced from the ancient counting tools to digital technology tools of today. Digital technologies made their appearance in mathematics education in the 1970s. Since then, computers equipped with increasingly sophisticated software, graphics calculators, and web-based applications offering virtual learning environments have changed the mathematics teaching and learning (Oldknow, Taylor, & Tetlow, 2010).

Our scope is to develop digital tools that will be used as educational material (for teaching and learning). With use of this education material, we want to engage students in building their own visualizations of mathematical concepts. In order to enable students to create such kind of visualizations, we use mathematics specific software, i.e. GeoGebra and Matlab. GeoGebra is open source dynamic mathematics software for teaching and learning mathematics from middle school through undergraduate university level (Hohenwarter, Preiner, & Yi, 2007). We chose GeoGebra because it combines the ease-of-use of dynamic geometry software with some basic features of computer algebra systems, and thereby helps to bridge concepts from geometry, algebra, and calculus. Moreover, GeoGebra can be used for active and problem-oriented teaching, which is important for PBL. Finally, in GeoGebra students can easily create constructions from scratch on their own and alter mathematical assignments in order to reach the solution, which is very fundamental to our application of constructionism. For the representation of mathematics in 3D, we use Matlab, which is a high-level language and interactive environment for numerical computation, visualization, and programming. We chose Matlab since it provides built-in 3-D plotting functions, as well as volume visualization functions. Furthermore, it is a tool that students in Media Technology (but also in studies we are focusing on) usually know how to use.

As a first step, we have implemented a set of applets with use of the aforementioned mathematics software that was introduced in the “Mathematics for Multimedia Applications”. The applets were used during the lectures by the professor, in order to better explain and visualize mathematical concepts. The same applets accompanied by questions about their content were available to students during their exercise time. In order to answer the questions the students should interact with the applets. An example of such an applet is shown in Figure 1.

The main characteristics of the proposed educational material are based on the basic principles of both constructionism and PBL. Moreover, it presents knowledge to undergraduate university students and engages them in a dynamic and interactive way. The reflection on using our material for teaching of mathematics combined with exploratory research on student background in and attitude towards mathematics will provide us with valuable knowledge in order to improve our design of educational material. Our ultimate goal is to implement and evaluate our approach within a specific university study (Media Technology), while defining a generic framework for implementing digital educational material that can be used to other university studies, where mathematics is not a core subject but it is essential for other core subjects.

4. Evaluation

In order to evaluate the first version of our educational material we are conducting focus group discussions with the group of students we observe during this semester. We chose focus group discussions rather than interviews because focus group discussion produces data and insights that would be less accessible without interaction found in a group setting. Listening to others’ verbalized experiences stimulates memories, ideas, and experiences in participants, which could not be achieved through a one-on-one interview. During these sessions one of our research team moderates the focus group discussion on students’ experience with specific course assignments.

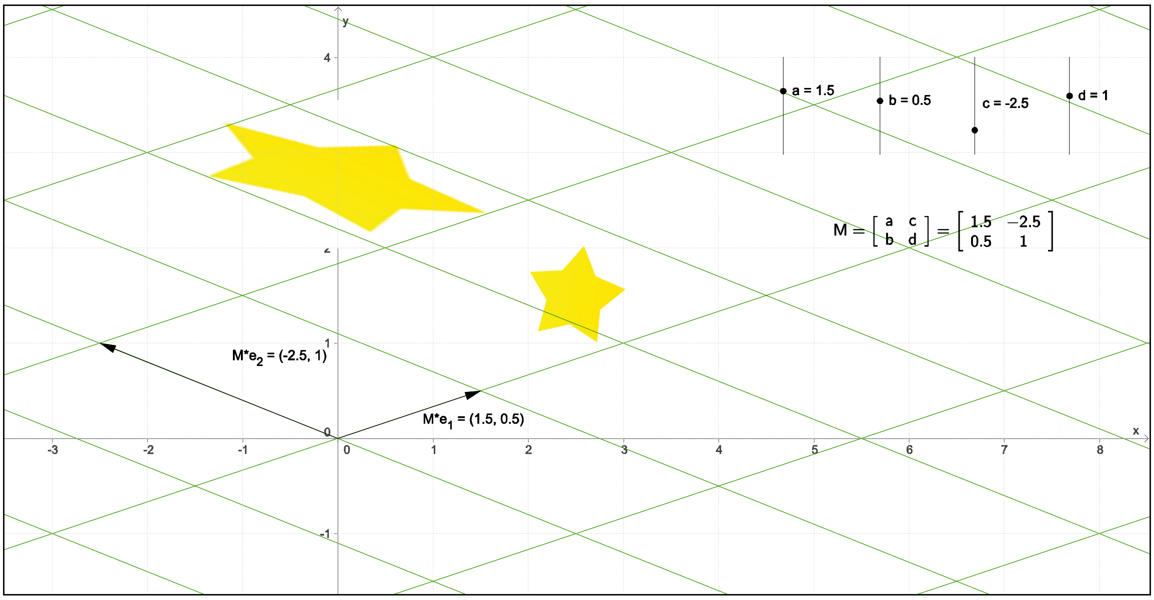

Figure 1. Visualizing Linear Transformations:
Students can change the matrix of the linear transformation by using the sliders, and observe how the grid and image are transformed

Moreover, we are conducting interviews with the professor and the teaching assistants involved in the “Mathematics for Multimedia Applications” course. Although teaching assistants play a subsidiary role in course, we believe that their contribution to our evaluation is valuable. By having the opportunity of supporting the students while they are working on their assignments, they get insight into which parts of the curriculum are challenging for students. Moreover, the current assistants have been also students in Media Technology and therefore have an overall perception of both teaching and learning of mathematics in this study. During these interviews we aim at getting feedback on how students worked in their assignments and whether and how they used the developed applets. Based on this feedback, we will be able to crosscheck the data we are gathering during the focus group discussions with students. Moreover, we seek proposals on improving our intervention based on their experience and observations.

5. Conclusion

The research presented in this paper will result in an educational model for mathematics teaching and learning, which will be evaluated in an undergraduate university setting. On one hand, we expect that the introduction of this material in teaching practice will enable teachers to combine constructionism pedagogical ideas with PBL, to teach mathematics in a wider context, and to adopt a student based strategy. The dynamic aspect of our approach will also contribute to teachers communicating their knowledge in a more effective manner. On the other hand, it is expected to help students assimilate mathematical knowledge and overcome their deficiencies regarding mathematics. An important aspect of our approach is that the level of interactivity of the developed educational material should be adjusted to university undergraduate students’ cognitive ability. If the learning tasks evolve fast and are complicated compared to students’ abilities, then they would not have any added value. On the other hand, if learning activities evolve slow or are trivial, students would easily lose interest. For defining the challenges that students face in mathematics, we are conducting observations in actual university classes, and interviews with teachers and students. This will also enable us to gain insight on problematic areas and adapt our research on dealing with them. Finally, we are able to develop student based solutions, which is very crucial if one wishes to improve student engagement and performance.

References

Akinsola, M. A., & Tella, A. (2007). Correlates of academic procrastination and mathematics achievement of university undergraduate students. *Eurasia Journal of Mathematics, Science and Technology Education*, 3(4), 363-370.

Bennett, R., (2003). Determinants of Undergraduate Student Drop Out Rates in a University Business Studies Department. *Journal of Further and Higher Education*, 27 (2), 123-141.

Bialek, W., & Botstein, D. (2004). Introductory science and mathematics education for 21st-century biologists. *Science*, 303 (5659), 788 – 790.

Borman, D., & Sleigh, A., (2011). An evaluation of the use of interactive approaches and integrated on-line resources. *Teaching Mathematics Applications*, 30(4), 166-177.

Boud, D. (1998). The challenge of problem based learning. Routledge.

Brent, R. (2004). Intuition and Innumeracy, *The Journal of Cell Biology Education*, 3, 85–92.

Dubinsky, E., & McDonald, M. A. (2001). APOS: A constructivist theory of learning in undergraduate mathematics education research. In D. Holton (Ed.), *The teaching and learning of mathematics at university level: An ICMI study* (New ICMI study series, 7, 273–280). Dordrecht: Kluwer.

Greene, J., & Foster, G. (2003). Public High School Graduation and College Readiness Rates in the United States. *New York: Manhattan Institute, Center for Civic Information*, Education Working Paper no. 3.

Harel, I. (1991). Children designers: Interdisciplinary constructions for learning and knowing mathematics in a computer-rich school. Ablex Publishing Corporation.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. *Educational Psychology Review*, 16(3), 235-266.

Hohenwarter, M., Preiner, J, & Yi, Taeil. (2007). Incorporating GeoGebra into teaching mathematics at the college level. *Proceedings of the International Conference for Technology in Collegiate Mathematics 2007*. Boston, USA: ICTCM.

Kafai, Y. B., & Resnick, M. (Eds.). (1996). Constructionism in practice: Designing, thinking, and learning in a digital world. Lawrence Erlbaum.

Kagesten, O. (1999). The consequences of an expanding university system on mathematical teaching. In W. Spunde, P. Cretchley and R. Hubbard (Eds.), *The challenge of diversity: Proceedings of the Delta' 99 symposium on undergraduate mathematics*, 114–117.

Kessel, C. and Linn, M. C. (1996). Grades or Scores: Predicting Future College Mathematics Peflormance. *Educational Measurement: Issues and Practice*, 15: 10–14.

Kitchen, A. (1999). The Changing Profile of Entrants to Mathematics at A Level and to Mathematical Subjects in Higher Education. *British Educational Research Journal*, 25 (1), 57-74.

Kjærsdam, F., & Enemark, S. (1994). The Aalborg Experiment. Project Innovation in University Education.

Kolmos, A., Fink, F.K., & Krogh, L. (2004). The Aalborg PBL Model. Aalborg: Aalborg University Press.

Laborde, C., Kynigos, C., Hollebrands, K., & Strässer, R. (2006). Teaching and learning geometry with technology. In *Handbook of research on the psychology of mathematics education: Past, present and future*, 275-304.

Martin, Andrew J., (2010). Should students have a gap year? Motivation and performance factors relevant to time out after completing school. *Journal of Educational Psychology*, 102(3), 561-576.

Maxwell, J. A. (2004). Qualitative research design: An interactive approach. Sage Publications, Incorporated.

Mustoe, L. (2001). The mathematics background of undergraduate engineers. *Proceedings of Progress 1 Conference on Student Progression and Retention in Engineering*. UK: Hull, 88–95.

Naftaliev, E., &Yerushalmy, M. (2011). Solving algebra problems with interactive diagrams: Demonstration and construction of examples. *Journal of Mathematical Behavior,* 30(1), 48-61.

Neville, A. J. (2009). Problem-based learning and medical education forty years on. Medical Principles and Practice, 18(1), 1-9.

Oldknow, A., Taylor, R., & Tetlow, L. (2010). Teaching Mathematics Using ICT, ISBN 9781441156884, Continuum International Publishing Group.

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. Basic Books, Inc.

Papert, S. (1986). Constructionism: A new opportunity for elementary science education. Massachusetts Institute of Technology, Media Laboratory, Epistemology and Learning Group.

Papert, S., & Harel, I. (1991). Situating Constructionism. In Papert, S., & I. Harel, Constructionism. Ablex Publishing Corporation, 193-206.

Timcenko, O. (2009). Mathematical modeling courses for Media technology students. In *The ICEE and ICEER 2009 Korea, International Conference on Engineering Education and Research*, 1, 60–66.

Valero, P., & Zevenbergen, R. (2004). Researching the socio-political dimensions of mathematics education: Issues of power in theory and methodology, (Eds.).

Wadsworth, B. J. (1996). Piaget's theory of cognitive and affective development: Foundations of constructivism (5th ed.), White Plains, NY, England: Longman Publishing.

Contextual Application for wiki project education in Moodle 2.3

Norazah bte Yusof [a] *, Shaffika bte Mohd Suhaimi[b], Mohd. Shahizan Othman[c] , Dewi Octaviani[d], Nadirah binti Mohamad[e]

Faculty of Computing
University Teknologi Malaysia
Skudai - Johor Bahru, 81100 Malaysia

Abstract

Moodle 2.3 is the latest e-learning system which contents a lot of improvements of social learning features. One of the social learning features in Moodle 2.3 is Wiki. Wiki is a collaborative tool among users. Wiki is allowing users to have experiences of efficiency, flexibility, and it is cost effective. In addition, contextual application learning is able to help instructors to relate the subject matter to the real situation in collaborative and constructive manner. Current research has found that there is lack of usage in the e-learning system among users especially for Wiki tool. One reason is that the users are not aware with the capability of wiki to support interactive learning environment. This paper concerns about the initiative of Moodle 2.3 for contextual application in wiki platform. This paper also analyses the usage of wiki by observing the data log of the student action in Computational Intelligence course, offered at the Faculty of Computing, Universiti Teknologi Malaysia. From this analysis, we are able to determine the active and passive attitude among students. These findings hopefully can guide the instructors to improve learning strategies, specifically on wiki contextual application method. It is able to encourage students' participation and make them more ready for future field work.

Keywords: Moodle 2.3 wike-education contextual application social interaction

1. Introduction

Learning is the action of gaining information and transforming it into knowledge. Current technology makes learning more fun than in a traditional classroom. Web-based technology enables learning to be accessible in global scale, in which it is called as e-learning. E-learning exploits interactive technologies and communication system to improve the learning experience. It can raise the standard of learning and widen the students' participation in lifelong learning. It can also enhance the quality of teaching and maintain the pedagogy. The most popular e-learning used by users is Moodle. Moodle has been widely used in higher education institutions because it is free and allow the organization to create their own learning plan. The current Moodle version, Moodle 2.3 is well equipped with social learning features. These features encourage students to have active interactions within the learning context.

However, students become too comfortable with the technology since they become passive in the process of learning. Current research found that students use e-learning system to retrieve the course materials and not so much as a tool for learning. To develop an active learning environment, learning experience must encourage students to create and do, not just think. It involves students to represent the learning results by the domains applying and creating (West and West, 2009). For example, it involves activities such as experimenting, planning, mapping, designing, composing and integrating. In order to emphasize students' interest and experiences throughout all the learning process, contextual approach is applicable. Contextual approach also focuses on learning through experiencing, not by memorizing the context and learning content (Satriani, et al., 2012).

With the rapid development of web technology, web based learning become one solution or a method to improve learning performance of student via collaborative learning. One of the collaborative tools is wiki technology. Wikis require no software and allows fully editable content and also easily to accessible. It is also capable to the contributors to feel a sense of responsibility and ownership. Wikis are everywhere, but the online literature has not yet begun to focus enough on wiki (Mattison, 2003).

In order to develop the encouragement of accessing social learning tools in e-learning, incentives should be taking into account. Giving marks in online learning contribution is one of the most widely used strategies (Khee Foon and Wing Sum, 2012). However, instructor become a dilemma in giving equal mark to each student who works on the same project. They might have students who contribute more to work than who contribute less. Brown stated that the instructor should know the identity of the student who has done each piece of work (Brown, 2004).

This paper discusses about contextual application uses wiki in Moodle 2.3. As wiki becomes a feature in teaching and learning process, this paper explains how the Moodle wiki is used to engage students to achieve their learning goals meaningfully. This paper also discusses on how to determine the student's participation ratio of individual in a group as well as in course activity. Other than that, marking guideline is provided to assess students participation.

* Norazah Bte Yusof. Tel.: +6-07-553 2341
E-mail address: norazah@utm.my

2. Contextual Learning Application in Wiki Moodle

Learning is an action which permit people to participate successfully in future life and environment involved in future; working environment (Cross, 2004). Cross also mentioned that Aristotle had said learning activities are absorbed most by doing, and it is a source of learning. Traditional learning such classroom is the main medium used in delivering the information and knowledge. Years by years, many methods have been introduced to get students get engage more in the learning environment. In late 1990 when technologies arise, web 2.0 is widely used in internet platform. Web 2.0 allows web users to create and exchange information actively among them. It also allows the user to upload and download media files by offering the multimedia platform. These features motivate them to participate in web activities and therefor enhance active interaction among web user (Chen, 2007).

E-learning is a learning space where enable students to explore and expand the knowledge without any boundaries. It creates a learning platform without limitation of space and time. Previous e-learning systems were based on content and instructional method that delivered on computer; CD-ROM, intranet or internet. These systems focused on the skills and knowledge of the students in computer-aided platform (Clark, 2008). Nevertheless, this system is not suitable to complete the needs of technology web for learning. Current e-learning is introduced with the compliments from social media tools and social learning concepts features. The social media enable students to establish and communicate in online connection (Kim and Jeoung, 2010). Example of social media tools are blogging, wiki, tagging, instant messaging content management system and also forum. While social concept features enable students to achieve three situations in learning; [1] changing of individual understanding, [2] changing of the situation from individual space to communities and [3] involving social network and interaction (Reed, 2010). The social learning concept becomes an important role in learning when it achieved three main activities such as knowledge exchanging, exploring and sharing.

The most popular e-learning in Malaysia is Moodle (Embi, 2009). Moodle is developed on open source system so that it gives the authorities for the institution to design base on their teaching and learning based on institution desire. Moodle came with many version of e-learning application. Previous Moodle, which is Moodle 1.0, consumed as close system. However current Moodle 2.0 is known as an open system because it embeds with social interaction features (Othman et. al. 2011). One of the social interaction features in Moodle is Wiki. Wiki is a collaborative tool that collects and organizes content, created and revise by its user. Wiki can potentially build the community. In wiki environment, students could share and discuss their project ideas. They also able to post their course material, maintain forum, write collaborative projects and enable them to develop a glossary of important terms (Peterson, 2009). West and West (2009) have listed some learning paradigm that use wiki to assist students in their collaborative projects. They claim that wiki is able to assist the learner in knowledge construction, critical thinking and also contextual application. Each learning paradigm uses a different approach on wiki environment to help students in their project task.

Table 1. Wiki Project for Contextual Application

Item	**Wiki Project for Contextual Application**	
	Applying	***Creating***
1	Event planning	Story creation
2	Process map	Team challenge
3	Virtual science lab	Media design project
4	Field research project	Service learning project

Contextual application is formed from contextual teaching and learning (CTL) strategies which are relating, experiencing, applying, cooperating and transferring (REACT) (Crawford, 2001). Contextual application in learning is one way method to help students connect the content they learned to the life context. It's also motivates students to connect with the knowledge and engage it with the hard work that learning requires (Berns and Erickson, 2001). Contextual learning is based on the premise that learning and meaning emerge from the relationship between content and context. It is the context [the environment mentor problem] that gives meaning to the content (Johnson, 2002). Contextual teaching and learning engage students in significant activities — in rich learning environments — that help them connect their academic learning to real life situations and problems. Crawford (2001) also mentioned that contextual application learning is active learning, not a passive learning. In this process, students are more focus on discussing with peers about their strategies for solving problems instead of having the right strategy told by the instructors. Active learning is occurred when students get actively participate in the learning process (Bonwell and Eason, 2012). Students are involving in activities such as higher order thinking skills [analysis, syntheses and evaluation]. Based on these actions, students are able to construct personal knowledge through experimentation environment and problems solving. However, passive learning refers to students' action on listening to lecture, memorizing, rephrasing and also observing (Allen.

2002). Students and context are not simultaneously involved in a same time. Due to the important of active learning environments in contextual application learning, Sinha et. al (2009) it is vital to have students in vital engagement with the content. Thus, collaborative wiki learning environment is a useful learning platform for students to become active in contextual learning application.

3. Methodology

In order to measure the wiki capability in contextual application, some methodologies are applied. The course named Computational Intelligence, offered at the Faculty of Computing, Universiti Teknologi Malaysia, is selected as the sample. There are 34 students in the course. These samples are divided into 9 groups, in which each group consists of three to four students. They have to use Wiki Moodle 2.3 as the learning platform. Besides the students, there is the instructor whose role is to be the main person who assigned the class's task and also responsible to monitor students' participation.

First, the instructor gives some examples on how to write a good technical paper, which include the introduction, the methodology, as well as the result and discussion part. Then, the instructor requires students to produce a journal paper on the topic about fuzzy inference system. This paper should be based on the students reading and understanding about the fuzzy topic. They have to find, search and understand about the fuzzy topic, and they have to create a research paper base on their understanding by collaborating with their peers. The students have to produce a complete journal paper through the wiki tool of the e-learning system. In the future, these skills can be used to produce other kind of research papers.

3.1. Contextual Application Interaction

In this work, contextual application method is used in Wiki Moodle 2.3 e-learning system as an interaction and collaborative tools. Figure 1 illustrates the interaction between each learner in the group to achieve task given. In this task, the instructor is giving to the group an assignment which is to describe Fuzzy inference System design. In this process, each member in each group is required to describe their own group project work. Each member must collaborate to produce a complete group task about fuzzy system.

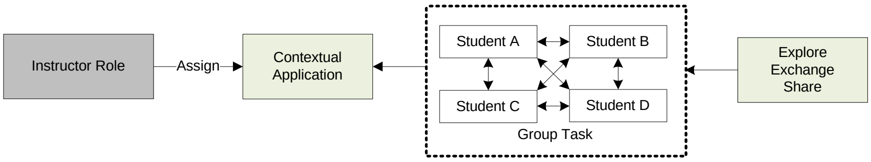

Figure 1. Contextual Application Interaction among students in Wiki Moodle 2.3

Figure 1 illustrates the interactions among students in performing the group tasks. When Student A is constructing his/her idea about the project, Student A is communicating, collaborating and cooperating with Student B, Student C and Student D. The students are interacting with each other simultaneously to produce the work. The skills involves are : exploring the context, exchanging the thought and sharing the benefits among group students. Throughout the process of creating the group tasks, students have full authority on the work done.

3.2. Wiki Data Log

Other method to measure learner participation is by observing the data log on wiki activity. The log data in wiki e-learning is observed to monitor the active and passive participation attitude of learner performance. Table 2 presents the log information which lists students action in wiki. The wiki data log provides six attributes with information based on the wiki activity. The information is explained in Table 2.

Course	Time	Ip Address	Student Name	Action	Information
SCJ4553-01	2012 October 19 19:33	161.139.18.154	Student Ag	wiki view	35407
SCJ4553-01	2012 October 20 23:23	161.139.18.154	Student R	wiki view	35407
SCJ4553-01	2012 October 20 23:23	161.139.18.154	Student R	wiki view	35407
SCJ4553-01	2012 October 20 23:23	161.139.18.154	Student R	wiki view	35407
SCJ4553-01	2012 October 22 12:28	10.60.87.18	Student R	wiki view	35407
SCJ4553-01	2012 October 22 14:26	10.60.87.57	Student U	wiki view	35407
SCJ4553-01	2012 October 22 15:09	10.60.87.82	Student X	wiki view	35407
SCJ4553-01	2012 October 22 15:10	10.60.87.82	Student X	wiki view	35407
SCJ4553-01	2012 October 22 15:10	10.60.87.84	Student C	wiki add page	137
SCJ4553-01	2012 October 22 15:10	10.60.87.84	Student C	wiki view	137
SCJ4553-01	2012 October 22 15:10	10.60.87.82	Student X	wiki view	130
SCJ4553-01	2012 October 22 15:11	10.60.87.82	Student X	wiki view	130
SCJ4553-01	2012 October 22 15:11	10.60.87.82	Student X	wiki comments	130
SCJ4553-01	2012 October 22 15:11	10.60.87.82	Student X	wiki history	130
SCJ4553-01	2012 October 22 15:11	10.60.87.82	Student X	wiki map	130
SCJ4553-01	2012 October 22 15:11	10.60.87.82	Student X	wiki view	130
SCJ4553-01	2012 October 22 15:13	10.60.87.84	Student C	wiki edit	137
SCJ4553-01	2012 October 22 15:13	10.60.87.84	Student C	wiki view	137
SCJ4553-01	2012 October 22 15:14	10.60.87.82	Student X	wiki view	35407
SCJ4553-01	2012 October 22 15:14	10.60.87.84	Student C	wiki view	137
SCJ4553-01	2012 October 22 15:15	10.60.87.82	Student X	wiki view	130
SCJ4553-01	2012 October 22 15:15	10.60.87.82	Student X	wiki edit	130
SCJ4553-01	2012 October 22 15:15	10.60.87.82	Student X	wiki view	130
SCJ4553-01	2012 October 22 15:15	10.60.87.82	Student X	wiki comments	130

Figure 2. Wiki data log student for contextual application.

Table 2. Wiki data log information

Item	Moodle Wiki	
	Attribute	***Explanation***
1	Course	Course taken by the learner. - Course code and class
2	Time	Date: Date learner access wiki Time: Time learner access wiki
3	IP address	IP address of students' laptop or computer
4	User full name	Students' name
5	Action	Action occur while they access wiki - Add, edit, comment, view, history and map.
6	Information	Version page visited

Based on Liu and Meng, (2010) it is important to measure the amounts of students' action identify those who are active and who are passive. In order to identify students' participation level, we have to observe access hits from the wiki data log. However, we cannot rely on hits only to determine that learning has occurred. Hence, a weight is introduced to calculate the students' hit. The score weighting is used as an indicator to show the importance of the meaningful characteristics in the learning process. For wiki activities, there are six actions to be categorized into 2 types namely active and passive. Active students can be considered as students who construct the knowledge such as creating a new page, commenting and editing on the existing one. However, passive students are considered who do the browsing, accessing map and review the history.

Table 3: Wiki data log information

Action	*Creating new*	*Make changes to the existing work for improvement*	*View and browsing*	*Does not reflect to learning process*
Weight	**3**	**2**	**1**	**0**
Wiki action	Add Comment	Edit History	View	Map

The steps to determine the students' participation level either active or passive is stated below:
First, the data log is sorted according to the wiki actions which are adding, edit, comment, view, history and map. Then, it classifies each action hits for each learner. Next, it counts the action score for each learner for active and passive action following the Equation (1):

$$\textbf{\textit{Action score}} = \sum_{j=1}^{a} \frac{h_j \times w_j}{Sum_j} \qquad (1)$$

Where *j* is an action in Wiki data log
h is the hits of each learner
w is the weight of each action
sum represents total

After we obtain the action score, the active and passive ratio for each learner participations are calculated as shown in Equation (2) and Equation (3).

$$(Active\ Ratio)\ y_A = \sum_{i=1}^{a}\left(\frac{x_i \times A}{Sum_x}\right) \times 100\% \quad (2)$$

$$(Passive\ Ratio)\ y_P = \sum_{i=1}^{a}\left(\frac{x_i \times P}{Sum_x}\right) \times 100\% \quad (3)$$

Where, *i* represents each learner in Moodle Wiki data log
y is total ratio each learner
x is the numbers of students' hit
sum represents total

Ratio calculation is important to measure students' participation in a group and also for a whole class.

4. Result and Discussion

Wiki Moodle 2.3 activity produces a 9 different group projects. Figure 3 shows the wiki page produced by the Group 4 Fuzzy Inference System Design task. Log history has been analyzed to identify students' participation in each group as well as in the whole class. The log data is retrieved to keep track of the students' activity in Wiki Moodle. The log has been sorted by the access hits on the wiki action. The hits are calculated into score which used to determine the active and passive score. Then, a graph is produced to determine the active and passive attitude. Figure 4 to Figure 11 show the graphs of the students' participation.

4.1. Contextual Application learning process in Wiki Moodle 2.3

Wiki Moodle 2.3 activity produced a group project task; Fuzzy Inference System Design produced by students. Instructor is received 9 different works represent by each group. Figure 3 below show the wiki page produced a group project done by each group.

Figure 3. Contextual Application learning in WikiMoodle.

4.2. Participation of individual in a group.

After the students have been sorted into their group, the score is calculated in Table 4. These scores use Equation (2) and Equation (3). The graph is produced to identify the students' participation level more clearly.

Table 4. Calculation for Wiki Data Log

Name	**Value**	**3**	**2**	**3**			**1**	**0**	**2**		
Student's Name	**Group**	**Add**	**edit**	**Comm**	**Ratio**	**Total**	**View**	**Map**	**History**	**Ratio**	**Total**
Student J	G1	3	16	6	37.88	66.00	32	0	1	30.84	107.00

Student U	G1	0	10	9	28.79	Ratio (%)	22	3	2	25.23	Ratio (%)
Student Ag	G1	0	6	0	9.09	9.94	27	0	0	25.23	5.98
Student Ah	G1	6	10	0	24.24		20	0	0	18.69	
Total		9	42	15	100.00		101	3	3	100.00	
Student R	G2	6	20	0	40.00	65.00	59	0	1	37.50	160.00
Student X	G2	3	22	4	44.62	Ratio (%)	66	1	1	42.50	Ratio (%)
Student Aa	G2	0	4	0	6.15	9.79	25	0	0	15.63	8.94
Student Af	G2	0	6	0	9.23		7	0	0	4.38	
Total		9	52	4	100.00		157	1	2	100.00	

………………..

The graphs below are representing the students' participation level based on their own group.

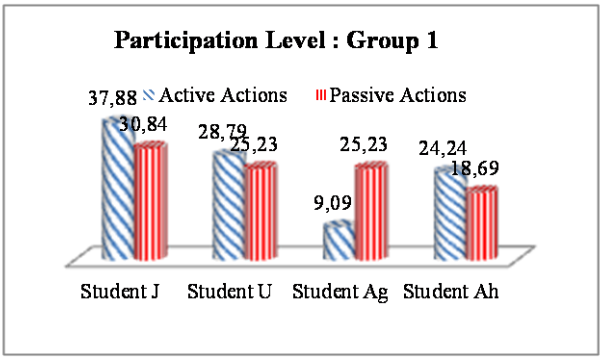

Figure 4. Level Participation for Group 1

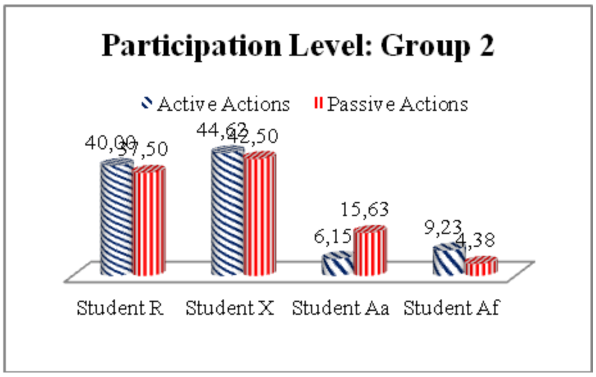

Figure 5. Level Participation for Group 2

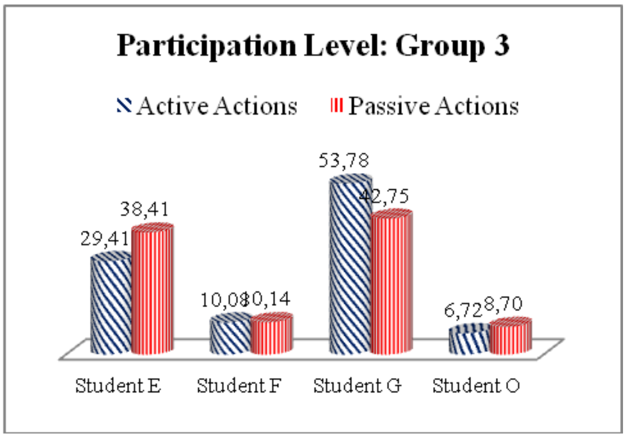

Figure 6. Level Participation for Group 3

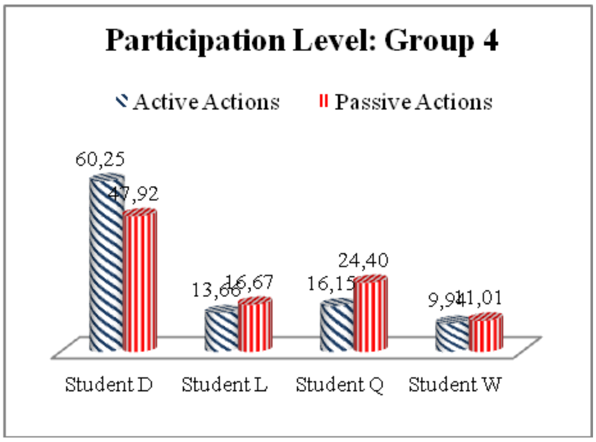

Figure 7. Level Participation for Group 4

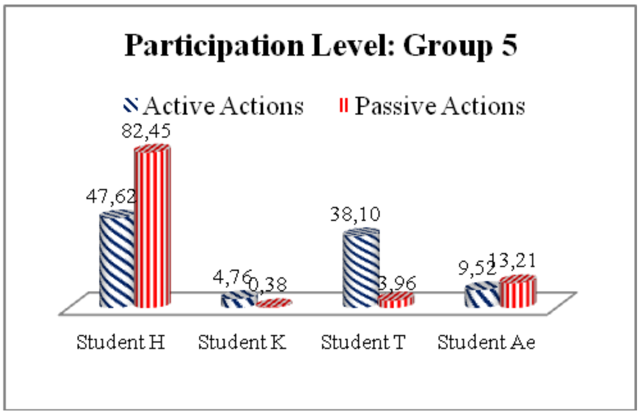

Figure 8. Level Participation for Group 5

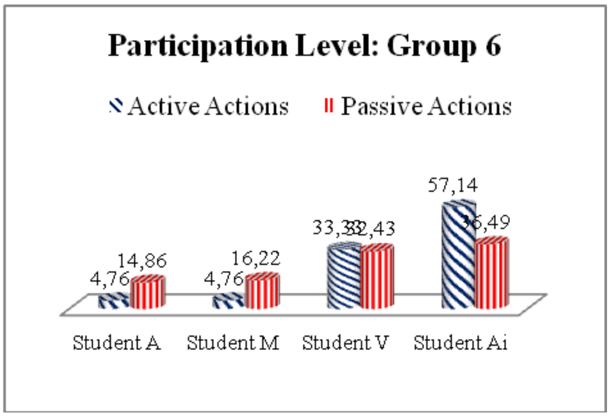

Figure 9. Level Participation for Group 6

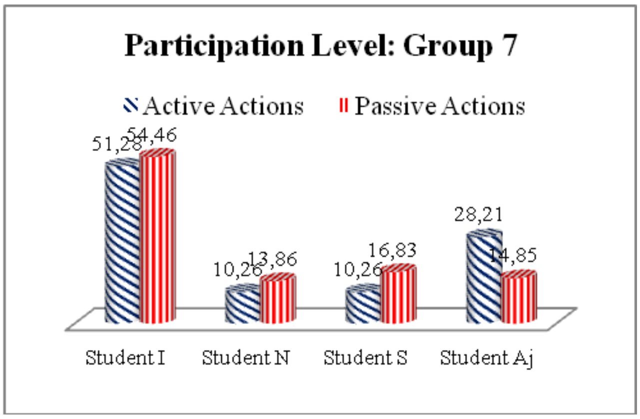

Figure 10. Level Participation for Group 7

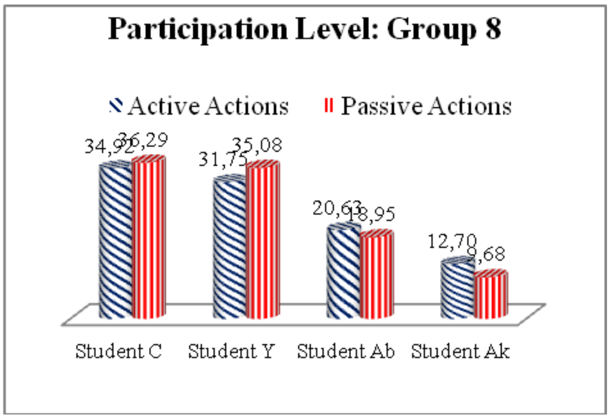

Figure 11. Level Participation for Group 8

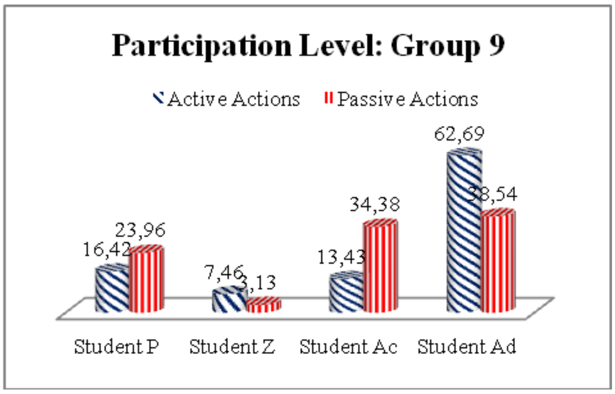

Figure 12. Level Participation for Group 9

Base on the figures, there are two groups which are Group 1 and Group 2 that show most of the students in the group are participating actively in the group task. Another four groups are participating moderately in their group. This mean that they have members who are active and passive. While other three groups which are Group 3, Group 4 and Group 7, there are two groups who have shown that most of the students in the group are passive participation.

4.3. Participation of the group in the class activity.

Participations from the whole class are important for the instructor to take further action. By producing the graph on the level of participation, helps the instructor to identify which group is not performing well in the task given. Instructor can motivate the group and encourage them to participate more to get the better result. Figure 12 shows that Group 4 is participated more both active and passive compared to other groups. Instructor has to focus on low participation level group, which is Group 6, and guide them to encourage the level of participation.

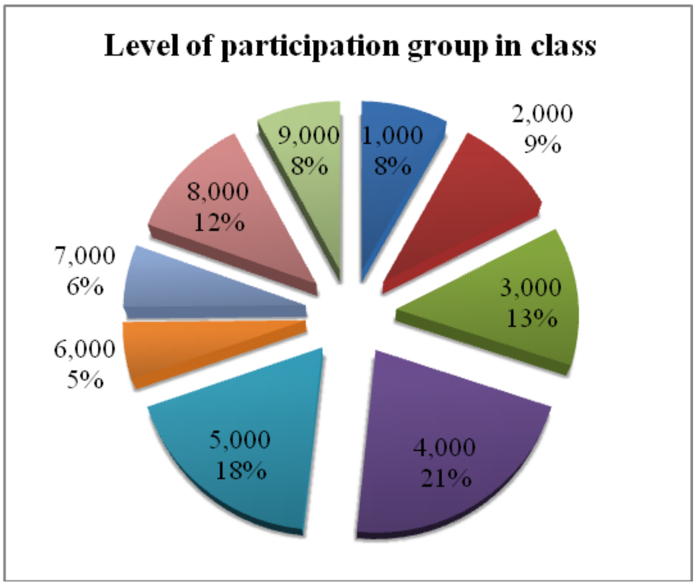

Figure 12. Participation of the group in the class activity

4.4. Students Assesment based on the participation.

Assesment become important after the level of participation among students are identified. In this study, the researcher had identified two methods of assesement. Firstly, the instructor is able to asses group participation level. This is means, among the group members in a group, instructor can identify those who in low motivation of participation and those who are very high motivation of participation. Secondly, the instructor also is able to give a mark to those students based on their active and passive actions. From the action score in Table 4, it can become the evidence for the distribution of mark to each student. The issue of given equal mark may no longger in a dilemma to the instructor how much mark to give to each student in a group.

5. Conclusion

This work presents a model of interaction used for contextual application in collaborative learning area. Wiki Moodle is a potential tool to engage students in the learning process. The analysis shown that the method used is successfully contributed to enhance learning performance; active and passive. Students can be identified as active and passive. Instructor also is able to identify which students need to be focused more. Other than that, instructors also can categorize which group has performed as very active and which group are not. Instructor can prepare strategic lesson plan to cope the passive issue among students. These findings can become the guideline for the instructor to assess student's participation.

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References

Allen, M. (2002). E-learning - Disovering learning: repurposing an old paradigm. 2002. Retreive online on Jan 2013 at: http://www.elearningpost.com/blog/e_learning_magazine_discovery_learning_repurposing.

Berns, R. G., & Erickson, P. M. (2001). Contextual teaching and learning: Preparing students for the new economy. National Dissemination Center for Career and Technical Education.

Bonwell, C. C., and J. A. (2013). Eison. Active learning: Creating excitement in the classroom. ASHE-ERIC Higher Education Report No. 1. Washington, DC: George Washington University Clearinghouse on HigherEducation. Accessed Januari 2013. Archived at http://www.webcitation.org/5Wl5FQQh7.

Brown, S. (2004). Assessment for Learning. Learning and Teaching in Higher Education, Issue 1.

Chen, Y., C. (2007) , Wiki Technology as a Scaffolding Tool in Education. Ninth IEEE International Symposium on Multimedia Workshops. Helsinki, Finland.

Clark, R. (2008). Six principles of effective eLeaning- what works and why: Best of the eLearning Guild's Solution. Pfeiffer a Wiley Imprint: United States.

Crawford, M., L. (2001). Teaching contextually: Research, rationale, and techniques for improving student motivation and acheivement in mathematics and science. Texas: CCI Publishing, Inc.

Cross, J. (2004). An informal history of eLearning. On the Horizon .Volume 12 · Number 3 · 2004 · (pp. 103-110). Online source: www.emeraldinsight.com/1074-8121.htm.

Embi, M. A. & Adun, M. N. (2010).e-Pembelajaran di IPTA Malaysia. Pusat Pembangunan Akademik Universiti Kebangsaan Malaysia, Jabatan Pengajian Tinggi Malaysia.

Johnson, E. B. (2002) Contextual teaching and learning: What it is and why it ' s here to stay . Thousand Oaks, CA : Sage .

Khe Foon. H., Wing Sum. C. (2012). Student Participation in Online Discussions: Challenges, Solutions, and Future Research. Springer.

Kim, W., and Jeong, O., R. (2009). On social e-learning. International Conference on Web-based Learning, Aachen, Germany.

Liu,H., Y., and Meng, X., J. (2010). Research on network teaching platform based on knowledge construction teaching model. In 2nd International conference on education technology and computer (ICETC), Shanghai.

Mattison, D. (2003). "Quickiwiki, Swiki, Twiki, Zwiki and the Plone Wars Wiki as a PIM and Collaborative Content Tool." Searcher 4(11): 32-48.

Othman, M. S., Mohamad, N., Yusuf L. M., Yusof, N. and Suhaimi S. M. (2012). An Analysis of e-Learning System Features in Supporting the True e-Learning 2.0. Proceedia - Social and Behavioral Science 56. p: 454-460. International Conference on Teaching and Learning in Higher Education (ICTLHE 2012) in conjunction with RCEE & RHED, Negeri Sembilan.

Peterson, E.(2009). Using a Wiki to Enhance Cooperative Learning in a Real Analysis Course, PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies, 19:1, 18-28.

Reed, M. S., A. C. Evely, G. Cundill, I. Fazey, J. Glass, A. Laing, J. Newig, B. Parrish, C. Prell, C.Raymond, and L. C. (2010). What is social learning; Ecology and Society. Stringer. [online source]. URL: http://www.ecologyandsociety.org/volXX/issYY/artZZ/.

Satriani, I., Emilia, E., and Gunawan, M. H. (2012). Contextual Teaching and Learning Approach to Teaching Writing. Indonesian Journal of Applied Linguistics, Vol. 2 No. 1, (pp. 10-22).

Sinha, N., L. Khreisat, and K. Sharma. (2009). Learner-interface interaction for technology-enhanced active learning. Innovate 5 (3). The Fischler School of Education and Human Services at Nova Southeastern University. Online source: http://www.innovateonline.info/index.php?view=article&id=622 (accessed January 2013).

West, J., and West, M., L. (2009). Using wikis for online collaboration. Online e-book. Wiley Imprint.

ICT-supported Learning in Medical PBL Pedagogy

Ashley E.R. Soosay[a]* and Souba Rethinasamy[b]

[a]*Faculy of Medicine & Health Sciences, UNIMAS, Kuching, 93150, Sarawak, Malaysia*
[b]*Centre for Language Studies,UNIMAS, Kota Samarahan, 94300, Sarawak, Malaysia*

Abstract

The utilization of information and communication technology (ICT) has gained a prominent role in teaching and learning. ICT has been proposed to enhance students' learning in a Problem Based Learning (PBL) environment. This study explored the use of ICT in a PBL Medical curriculum and investigated students' feedback on this effort. The data were gathered from ten first year medical students through the use of questionnaire, group and individual interviews. The findings show that the provision and facilitation for the use of ICT increased their interest in PBL, helped recall information, enabled better interaction with group members and enhanced their learning. The paper discusses the implications of the findings on meaningful learning.

Keywords: Information and Communication Technology (ICT), Problem Based Learning (PBL), Medical pedagogy

1. Introduction

Problem-based-learning (PBL) is a student-centered-learning method. PBL focuses on promoting a learning context in which the participants collaboratively learn beyond their potential by internalizing the subject matter and developing higher order thinking. Thus, PBL is often advocated as one of the most powerful pedagogical approaches for effective learning especially in higher education.

The worldwide spread of PBL is attributed to the introduction of this educational method at the Medical School of McMaster University in late 1960s (de Graaff & Kolmos, 2007). The McMaster medical curriculum blueprint for PBL introduced an exciting educational philosophy for medical schools. The impetus was on the application in practice as opposed to storing facts by rote learning. This philosophy promulgates that the student should focus on the patients' complaints. Systematic analysis of patients' problems by students will enable them to formulate questions with regard to the information the students' require to strengthen their prior knowledge and eventually identify their learning needs. According to Barrows and Tamblyn (as cited in de Graff & Kolmos, 2007), PBL paradigm integrates knowledge from different disciplines related to medical problem and this makes students' learning experience more applicable, exciting and meaningful.

The benefits of PBL include critical and creative reasoning, communicating and interacting in meaningful team collaboration, appreciating alternative viewpoints, making reasoned decisions, self-evaluation and self-directed-learning (Nelson, 2005). PBL induces effective adult learning such as active learning, integrated learning, cumulative learning and learning for understanding. Barrows (1996) outlined six original characteristics for the PBL model. Firstly, the learning is student-centered, learning occurs in small student groups, teachers function as facilitators, problems form the original focus and stimulus for learning, problems are vehicles for the development of problem solving skills and the last characteristic is that new information is acquired through self-directed learning.

PBL's potential to enhance meaningful learning will fail without the necessary tools and access to resources. The tools are not restricted to the transformation of nature, but certainly directed towards social and mental activities as well (Dircknick, 2009). According to Vygotsky's (1978) socio-cultural approach to learning, tools fundamentally mediate higher mental functioning and human actions. Dircknick (2009) argued that ICT can be used as a tool to organise information. ICT as a tool has gained an essential and permanent role in present day educational settings. ICT provides a learning infrastructure which acts as an expedient for PBL implementation.

PBL has been adopted, adapted and improved at the Faculty of Medicine and Health Sciences (FMHS) in Universiti Malaysia Sarawak (UNIMAS) since its establishment in 1995. The mechanism of PBL implementation at FMHS UNIMAS has three phases, which are, introduction of trigger, gathering of information pertaining to the learning needs of the trigger and discussion of the newly gained knowledge pertaining to the learning needs of the trigger. The trigger introduction is usually done on Monday morning and the discussion is done on Friday afternoon. Between Monday morning and Friday afternoon, the students are given sufficient self directed learning (SDL) hours to gather information regarding the learning needs of the trigger. The following week, the students encounter a new trigger. It was noted that the students generally spend approximately 1-2 hours on Monday and 2-3 hours on Friday for the face-to-face component of PBL. Although the PBL room is well equipped with ICT facilities, it was found that the students were not engaging the facilities provided. In addition, during the PBL sessions, the students were found busy with some futile activities such as writing on the white board, copying from the white board and personal note taking. We realized that the time spent on these trivial activities can be used for quality discussion session. In order

* Ashley Soosay. Tel.: +6-016-878-2315
E-mail address: sashley@fmhs.unimas.my

to make the PBL process efficient and well managed, ICT-supported learning techniques were utilized and introduced to the students. Therefore, this study was planned and executed to investigate students' feedback on the integration of ICT-supported learning during PBL implementation at FMHS UNIMAS.

2. Methodology

The aim of this study was to discover students' learning experience on using ICT during the implementation of the PBL process. There were 12 PBL groups in this cohort of medical students. As a facilitator, we employed ICT-supported learning techniques in one of these PBL groups. Our priority was to examine the students' perception of their learning experience in using ICT-supported learning techniques. The study employed a mix method approach using questionnaire and semi-structured interview. According to Flynn (2005), the inclusion of qualitative data benefits the richness and validity of gathered data.

2.1. Research site: Faculty of Medicine & Health Sciences (FMHS), UNIMAS

At the FMHS, UNIMAS a PBL group may consist of 9 or 10 students. The students are divided according to several criteria. Mainly, the PBL groups are based on gender, ethnicity, state of origin, Malaysian University English Test (MUET) band scores and academic status. Where possible, attempts are made to distribute an equal number of students according to the criteria mentioned. In the programme's weekly time table, a minimum of 8-10 hours are designated for self-directed-learning (SDL) activities between Monday and Friday. In addition, between the PBL sessions, the students are given pertinent lectures to supplement the PBL curriculum. The medical programme is based on organ-system curriculum. When the students enter the medical programme, they undergo a two day PBL workshop. During the workshop, the students are exposed to the concept of PBL, the roles and responsibility of students in PBL, the roles and responsibility of the facilitators in PBL and the Faculty's expectations. The students are also exposed to a simulated PBL followed by a video presentation of the implementation of PBL in the faculty.

A typical PBL group session comprises of trigger on Monday mornings and discussion on a Friday afternoon. These sessions take place in PBL rooms which are specifically designated for PBL related activities. Each PBL group is furnished with a roundtable format discussion room. In addition, the faculty provides each PBL room with a standard mobile white board, a pull down screen, LCD projector, direct video projector, a four-tier steel locker cabinet and a desktop computer. The students are also able to use free wireless fidelity (Wi-Fi) and their own ICT devices such as laptop, iPad, Tablet PC and smart phones.

2.2. PBL process at FMHS

The PBL process begins with identifying difficult terminologies, followed by gathering of facts and generating ideas and lastly to form the learning needs to bridge the knowledge gap so that the problem is better understood. This activity requires about 1-2 face-to-face contact hours. Normally the students would divide the white board into four columns. The first column for listing difficult terminologies, the second column for facts gathered from the trigger, the third column for ideas generated during trigger discussion and the fourth column for formulating their learning needs. During the Friday PBL discussion sessions, the students would bring teaching and learning aids in the form of anatomical models, charts and other materials to facilitate their discussion. At times students draw on the white board before starting any discussions. The discussion activity generally requires 2-3 face-to-face contact hours. During PBL group sessions, students spend approximately 25% of the overall time looking for meanings of difficult words in dictionary, text books, copying written notes from the white board and personal note taking.

2.3. The study group

In this study, the PBL facilitator demonstrated to a group of 10 first year medical students how to use a MS word file with a landscape page layout orientation to form the four columns. It was aimed to mimic the white board and enable the thought processes to be saved digitally upon completion and ready for sharing via their preferred social media such as Facebook (FB). The instructor also showed the students how to use the mobile digital dictionary, word processing and presentation tools to obtain information related to the PBL process. The use of digital camera or camera function in mobile phones was also highlighted. The social networking platform was encouraged for obtaining and sharing resources. Finally students were exposed to and emboldened to take advantage of the rich experience of Web 2.0 tools such as YouTube, Social Network Media and Dropbox.

2.4. Participants

The study involved ten first year medical students at the FMHS, UNIMAS. These ten students belonged to a cohort of 115 students, who were grouped into 12 separate PBL groups. The groupings were done based on explanation given in Section 2.1 of this paper. These students were exposed to ICT-supported learning techniques from the second PBL session onwards. The small number of respondents is due to the nature of PBL implementation (Lesperance, 2008; Park, 2008).

2.5. Data collection tool

Research instruments used in this study were questionnaire and semi-structured interview. The survey questionnaire contained three sections. Section One consisted of basic demographic data which covered personal information such as gender, school background, year of study and Malaysian University English Test (MUET) band score. Section Two consisted of 17 items which focused on the students' experience in using ICT during their PBL discussions. Each item was followed by a 5-point Likert options which were Strongly Disagree (SD), Disagree (D), Unsure (U), Agree (A), and Strongly Agree (SA). Section Three contained two open ended questions which were aimed to elicit students' detailed information based on their responses to the questionnaire items in Section Two. The questionnaire items were adapted from Hazari et al.'s (2009) study on the use of ICT in teaching and learning. The opinions of two experts were obtained to maintain content validity of the questionnaire and a pilot study was conducted with three second year medical students. Based on the feedback, minor corrections were made and the final version was used in this study. The interview focused on the students' experience in using the ICT-supported learning techniques introduced to them. Besides that, data on the benefits gained and challenges faced were also elicited. In addition, the students were also asked whether they would continue to use and recommend the techniques to their classmates.

2.6. Data collection procedure

The questionnaire was administered to ten first year medical students. Prior to data collection, the ten students had experienced seven PBL sessions. The students were shown and encouraged to use ICT-supported learning techniques from the second PBL session onwards. Before administering data collection, the students were briefed on the aim of the survey and respondents' consent for participating in this study was obtained. It took approximately 10-15 minutes for the students to complete the questionnaire. Upon completion they were interviewed as a group and this was followed by one-to-one interviews based on their responses to the questionnaire items. The questionnaire data were analysed using descriptive statistics and the results are explained with the qualitative data obtained from the interview sessions.

3. Results

3.1. Time

Nine of the ten students (90%) in this group agreed or strongly agreed that the application of ICT in the implementation of PBL was worth their time. Only a small minority were unsure of this matter. Seven (70%) of them also either agreed or strongly agreed that the use of ICT during PBL helped them to save time. The remaining three students (30%) were unsure on this matter. Qualitative data from the interview with the respondents indicate that the students found the use of ICT during PBL was worth their time because less time was spent on copying material from the white board. One of the participants who responded neutral explained that it was not time efficient because the group had to wait for the person who was typing on the keyboard to complete the task. The following are sample excerpts from the interview.

Student A: *Using ICT tools has certainly helped us because we do not have to wait until the Scribber finish writing on the board.*

Student F: *It helps me to save time.*

3.2. Effort

Eight of the ten respondents (80%) agreed or strongly agreed that the application of ICT in the implementation of PBL was worth their effort. Only two students (20%) were unsure of this matter. The interview with the respondents indicate that the students found the use of ICT during PBL was worth their effort because it enabled them to be more engaged in the PBL activities. For example, they mentioned that the time saved through the use of ICT enabled them to spend more quality time on the discussions. The following interview excerpts exemplify this point.

Student D: *Can see the fruits of our effort.*

Student H: *We have more time for discussing.*

3.3. Interest in PBL

Nine of the ten students (90%) either agreed or strongly agreed that the use of ICT in the implementation of PBL has made them more interested in PBL. One student was unsure of this matter. Qualitative data from the interviews with the respondents explain that the increase in interest was mainly due to the fact that the use of ICT enabled them to access a variety of resources and share them with their group members easily. In addition, they also explained that the use of these multi resources enriched their learning experience. Below are sample excerpts which support this claim.

Student B: *It makes me interested to come to PBL sessions.*

Student F: *I enjoy using technology during PBL session as it makes our session more efficient and interesting.*

3.4. Interact with members

Eight of the ten students (80%) in this study either agreed or strongly agreed that the use of ICT helped them to interact more effectively with their group members during PBL discussion. During the interview, the students explained that the use of ICT during PBL enabled them to be more efficient and free of futile endeavours especially manual note taking. This effort in turn enabled them to share resources effectively and interact meaningfully with group members. The sample excerpt below illustrates this point.

Student E: *Make everything easier, no need to write on paper. Just type it and share it on the internet with everyone.*

3.5. Opportunity to interact

Six of the ten respondents (60%) either agreed or strongly agreed that the use of ICT gave them the opportunity to interact better with their group members during PBL discussions. Interestingly the qualitative data from the interview with the respondents show that some of the respondents were not quite aware of the opportunity provided through the use of ICT to interact with group members. Three students who responded positively on the item related to the use of ICT in helping them to interact with group members, responded unsure to the item on the opportunity to interact. During the individual interview, the students agreed that the experience of using ICT helped them to interact better with their group members but they were unaware that the opportunity actually presented itself. On the other hand, only one student was aware of the opportunity presented but the student did not seize it. Overall, the consensus was that the interactions among group members were better due to the use of ICT during PBL.

3.6. Task Completion

Seven of the ten students (70%) either agreed or strongly agreed that the use of ICT enabled them to complete their PBL task more efficiently. The qualitative data shows that students were more efficient when ICT was used because the utilization of their personal ICTdevices enabled them to participate effectively and efficiently in the process of completing the assigned task. The following excerpt highlights this point.

Student J: *Technology helps us a lot in completing the task*

3.7. Effectiveness

Eight of the ten respondents (80%) either agreed or strongly agreed that the use of ICT during PBL made their group become more effective. The remaining two students (20%) were unsure on this matter. During the interview the students clarified that they were effective in achieving their objectives during the PBL sessions because ICT enabled them to be resourceful and efficient in gathering the required information. The following excerpt exemplifies this point.

Student F: *I gain a lot of information when I do research on the internet. I enjoy using technology during PBL session as it makes our session more efficient and interesting.*

3.8. Active participation

Seven of the ten students (70%) either agreed or strongly agreed that the use of ICT during PBL made them become an active participant during PBL. The other three students (30%) were unsure on this matter. The qualitative data obtained through interviews show that the students were more confident during active discussions because the ICT tool provided evidence of their argument. The availability of this information boosted their confidence during discussion. The following sample excerpt below illustrates this point.

Student G: *Technology helps me to explain the information more clearly. More resources are used. I feel more confident.*

3.9 Achieving objectives

Seven of the ten students (70%) either agreed or strongly agreed that the use of ICT during PBL have helped them to achieve their objectives. Their interview data indicate that the students felt happy that their goals were easily attained when ICT was used during PBL. The feeling of happiness makes the student be more interested in the PBL approach. The following sample excerpt below depicts this point.

Student I: *Technology helps me to stay focused on our goals and because of this we are able to achieve our aims easily.*

3.10. Enhanced learning

All the respondents (10/10) either agreed or strongly agreed that the use of ICT during PBL enhanced their learning. The interview data also concur with this response. All students indicated that the use of ICT has enhanced their retention of knowledge more efficiently and made PBL learning more meaningful. The following excerpt validates this point.

Student C: *I am able to remember better what I have learnt.*

3.11. Easy to use ICT

While eight respondents (80%) agreed or strongly agreed that it was easy to use technology during PBL, one of them (10%) was unsure and another (10%) disagreed that it was easy to use technology during PBL. During the interview, the student clarified that it was not easy to use the technology due to unfamiliarity in the initial stage. However, as time passed the student began to be more accustomed to the use of the gadgets in the PBL room. For example, toggling between LCD projector and video projector seemed to be a problem at times and also unplugging the desktop DVI cable and putting in the right port on the laptop was a daunting task, initially. The following excerpt validates this claim.

Student F: *Some of the technologies were difficult to use at first but I got the hang of it, its ok.*

3.12. The problem faced while using ICT

Only six respondents (60%) agreed or strongly agreed that they did not face any problem while using technology during PBL. On the other hand, three of them (30%) were unsure on this matter and one (10%) indicated having faced difficulty while using technology during PBL. The interview data show that the difficulties faced were solely due to the lack of familiarity with the functionality of the devices and technical problems such as slow Wifi connection which was occasionally encountered while using the technology. The following excerpt provides support for this claim.

Student D: *Sometimes the connection is rather slow, making things difficult and frustrating.*

3.13 Visualization

Eight of the ten respondents (80%) either agreed or strongly agreed that visualization using technology have helped them to visualise the materials discussed during PBL. The remaining two students (20%) were unsure about the matter. The qualitative data indicate that students were motivated to use ICT during PBL because the tools enabled them to visualize the learning material better and this in turn helped enhance understanding. Students liked to use the whiteboard for brainstorming activity such as mind mapping. They created the mind mapping work as tight as possible on the white board so that a digital photo could be captured and shared with the group members via Facebook. Furthermore, students reported that the materials from e-book, digital textbook and YouTube videos were shared among group members. Textbook drawings, potted specimens and anatomical models were shown using direct video presenters. This multimedia enriched learning environment also enabled them to retain the knowledge gained through audio and visualization. The following excerpts provide support for this claim.

Student B: The visual aid enhances our memory on the topics discussed.

Student C: It is a good way to explain subject matter or visualizing content that are hard to explain.

Student D: We used to show video on topics of interest and it makes us see things better.

Student G: Technology helps me to explain the information more clearly.

Student I: Technology such as multimedia provide us a better picture of what we are learning. It helps us to retain information longer through the use of pictures and audio.

3.14 Continue using technology during PBL

All the ten respondents (100%) either agreed or strongly agreed that they would continue using ICT during PBL. This is clearly reflected in the qualitative data obtained, where all respondents expressed that they were excited and looking forward for the next PBL. The following excerpt exemplifies this point.

Student H: The technology really help me with learning and I will definitely continue to use them.

3.15 Future Recommendation

While eight of the ten respondents (80%) either agreed or strongly agreed that they would recommend their friends in other PBL groups to use technology during PBL, two (20%) were not sure if they would make such recommendation. During the interview students who were keen to recommend said that the use of ICT may motivate students who dislike PBL because ICT encourages active involvement during PBL. The following excerpt exemplifies this point.

Student C: Students generally tend to dislike PBL but ICT makes it easy for everyone to participate actively so I will recommend to my friends and juniors.

4. Discussion

This study aimed to discover students' opinions on the utilization of ICT-supported learning techniques in PBL learning context. The findings show that the implementation enabled students to save time and effort, enhanced their interest, enabled information retention, provided better opportunities to interact with group members, and work more effectively as a group during PBL. Barrows (1996) highlighted that three of the six characteristics of PBL are student dependent. The three characteristics are learning is learner centered, occurs in a small group and self directed learning (SDL) is the impetus for the acquisition of new knowledge. The findings show that these three characteristics can be enhanced by using tools that make learning more effective and meaningful. Leidner (1995) highlighted that one of the pertinent tools is ICT. In line with this, four forms of ICT were engaged in this study. They were mobile digital dictionary, digital presentation tool, digital photo capture and social networking media. The utilizations of these ICT tools seem to influence the student dependent characteristics of PBL in a positive manner.

Sunchana *et al.* (2005) showed that blended world wide web (www) based learning and PBL collaborative environment was positively affected by the use of technology. Similarly, the participants of this study group exhibited enhanced learning when subjected to the use of ICT during PBL. Castro-Sanchez *et al.* (2012) showed that PBL facilitates learning strategies and study preferences. Castro-Sanchez *et al.* also reported that PBL students' highly rated study preference were linked to learning style of logical, social, physical, verbal and visualization. The present study's findings also show that visualization of knowledge through the use of ICT during PBL enhances their retention of the knowledge learned. Similarly, Blackbourn *et al.* (2008) study showed that the use of wireless technology in a PBL class augments students' participation and satisfaction. Likewise, in this study the participants' feedbacks on the use of ICT during PBL discussion, concur with Blackbourn's notion. The present study group members said that the utilization of personal ICT devices enabled them to complete the PBL task efficiently, therefore imbuing them with the sense of accomplishment.

Dirckinck-Holmfeld (2009) argued that face-to-face method and computer networks affect the usual time patterns of teaching and learning. It was further explained that teaching and learning environment can be organised more flexibly due to the asynchronous nature of the ICT. The findings of the present study indicated that the introduction of mobile and ubiquitous computing devices have made learning effortless. Moreover, the culture of using ICT during PBL has been extended to non-PBL time and students tend to be involved in diversified resource seeking. This strategy seems to enhance their overall learning experience. The idea of education and access to information taking place anytime, anyplace and anywhere is a reality. The findings of the present study support Dirckinck-Holmfeld's (2009) argument. The output of synchronous in combination with asynchronous activity among the group members, afford reflective, active, collaborative teaching and learning at all times.

The present study also showed that students use smart phones during the PBL session to capture images, access and share information. Similar findings were also observed in a recent study conducted by Utulu and Alonge (2012). They found that a significant percentage of the students used mobile phones to communicate, interact, obtain information, browse internet and share knowledge anytime anywhere when they were involved in PBL. This shows that utilization of student preferred personal ICT devices should be permitted during teaching and learning processes as they offer active and engaging learning experience for students.

The merging of ICT with PBL has vast potential to serve as a catalyst for educational reform (Dirckinck-Holmfeld, 2009; Moersch, 1995). PBL pedagogy is meant to make students interact and engage in active learning. The findings of this study show that ICT tools enable students to be more resourceful, collaborate effectively and create a rich and meaningful learning environment. Thus, ICT is recommended to be used to facilitate the display of information, to increase access to external digital resources and to increase the dissemination and construction of knowledge during PBL implementation.

5. Conclusion

PBL is often recommended as an effective teaching-learning pedagogy. However, it is often advocated that its potential to enhance meaningful learning will be affected without the necessary tools and access to resources. Thus, this study was aimed to investigate students' feedback on the integration of ICT-supported learning techniques during PBL implementation in a Medical PBL curriculum. In particular, mobile digital dictionary, digital presentation tools, digital photo capture and social networking media were used to enrich the learning experience of PBL students. This study has revealed the positive influence of ICT-supported learning techniques on PBL process. It is not that ICT is a panacea for teaching and learning ills but ICT can certainly help pave the path for active learning to take place. Through active learning the acquisition of knowledge can be made more pleasant and meaningful for students.

In summary, factors pertaining to ICT-supported learning during the PBL process that have a positive effect on learning experience include:

1. Time saving provides effective discussion
2. Enhanced retention of information
3. Efficient and interesting PBL sessions
4. Increase connection or interaction between members
5. Audio together with digital visual aid enrich learning experience

The factors explicated in this study will be useful for facilitators to engage students actively in a PBL learning environment. Diverse pedagogical tactics such as ICT-supported learning will enhance, enrich student learning and assist students achieve their learning goals effectively. Therefore we propose that ICT-supported learning techniques should be encouraged and embedded during the implementation of PBL.

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References

Akbiyik, C., & Seferoglu, S. S. (2012). Instructing ict lessons in primary schools: teachers' opinions and applications. *Kuram ve Uygulamada Egitim Bilimleri, 12*(1), 417-424.

Barrows, H. S. (1996). *Problem-based learning in medicine and beyond: A brief overview.* San Franscisco, CA: Jossey-Bass Inc.

Blackbourn, J. M., Fillingim, J. G., McCelland, S., Elrod, G. F., Medley, M. B., Kritsonis, M. A., *et al.* (2008). The use of wireless technology to augment problem-based learning in special education preservice teacher training. *Journal of Instructional Psychology, 35*(2), 169-176.

Castro-Sanchez, A. M., Aguilar-Ferrandiz, M.E., Mataran-Penarrocha, G. A., Iglesias-Alonso, A. A., Fernandez-Fernandez, M. J.., & Moreno-Lorenzo, C. C. (2012). Problem based learning approaches to the technology education of physical therapy students. *Medical Teacher, 34*(1), 29-45.

de-Graaff, & Kolmos, A. (2007). *History of problem-based and project-based learning.* Rotterdam: Sense Publishers.

Dirckinck-Holmfeld, L. (2009). Innovation of problem based learning through ict: linking local and global experiences. *International Journal of Education and Development Using Information and Communication Technology, 5*(1), 3-12.

Flynn, A., Concannon, F. & Ní Bheacháin, C. (2005). Undergraduate students' perceptions of technology-supported learning: The case of an accounting class. *International Journal on E-Learning, 4* (4), 427-444.

Hazari, S., North, A., & Moreland, D. (2009). Investigating pedagogical value of Wiki technology, *Journal of Information Systems Education, 20*(2), 187-198.

Leidner, D. E., & Jarvenpaa, S. L. (1995). The use of information technology to enhance Management School Education: A theoretical view. *MIS Quarterly, 19(*3*),* 265-291.

Lesperance, M. M. (2008). *The effects of Problem Based Learning (PBL) on students' critical thinking skills.* Unpublished Ed.D., The University of North Carolina at Greensboro, North Carolina, United States.

Moersch, C. (1995). Levels of technology implementation (LoTi): A framework for measuring classroom technology use. *Learning and Leading with Technology*,*23*(3), 40-42.

Nelson, L., Sadler, L., & Surtees, G. (2005). Bringing problem based learning to life using virtual reality. *Nurse Education in Practice, 5*(2), 103-108.

Park, S. H., & Ertmer, P. A. (2007). Impact of Problem-Based Learning (PBL) on teachers' beliefs regarding technology use, *Journal of Research on Technology in Education*,*4*0(2), 247-267.

Suncana K. T., Taradi, M., Radic, K., & Pokrajac, N. (2005). Blending problem-based learning with Web technology positively impacts student learning outcomes in acid-base physiology. *Advances in Physiology Education*, *29*, 35-39.

Utulu, S. C., & Alonge, A. (2012). Use of mobile phones for project based learning by undergraduate students of Nigerian private universities, *International Journal of Education and Development Using Information and Communication Technology, 8*(1), 4-15.

Vygotsky, L. (1978). *Mind in society. The development of higher psychological processes.* Cambridge, US: Harvard University Press.

Integration of Cloud Based Learning in Project Oriented Design Based Learning

Jaideep Chandran [a] *, Sivachandran Chandrasekaran [a], Alex Stojcevski [a]

[a]*School of Engineering, Deakin University,Waurn Ponds, Geelong, 3216, Australia*

Abstract

The School of Engineering at Deakin University has been practicing design based learning as one of its engineering learning principles for further development in the learning and teaching process. It has been exploring the student and industry perspectives in this regards and has embarked in the development of a new framework for a project oriented design based learning approach for the development of the engineering curriculum. Along with this change in the engineering curriculum Deakin University also has been going through a major change in the delivery of education. The policy shift has been initiated through Live the Future: Agenda 2020 which focusses on Cloud and Located Learning. This change in policy has had an impact on delivery framework for the project oriented design based learning model which has been incorporated through the use of lecture videos, a learning management system called Cloud Deakin and online tutorials through the eLive system.

Keywords: design based learning, cloud learning , project based learning

1. Introduction

1.1 Project oriented design based learning

In learning and teaching, practicing design is one of the fundamental processes in engineering curriculum and all other engineering activities related to it. Deakin engineering uses design based learning as one of its engineering learning principles for further development in learning and teaching process. Design based learning (DBL) a self-directed approach in which students initiate learning by designing creative and innovative practical solutions to fulfill academic and industry expectations. It is an effective vehicle for learning centred on a deisgn problem solving structure adopted from a combination of problem and project based learning (Dopplet, 2009). Learning is an active process of investigation and creation based on learner's interest, experience and curiosity and it should result in expanded knowledge and skills. Learning through projects is considered as a way of interactive learning (S. Chandrasekaran and A. Stojcevski, 2012a). The perceptions of engineering students at Deakin University indicated that they believed that DBL was a useful learning and teaching approach, which would be helpful for their future career opportunities (S. Chandrasekaran and A. Stojcevski, 2012b; Dopplet 2009).

By aligning the ongoing study on student perspectives with the investigated industry views, a new framework for the newly proposed project oriented design based learning (PODBL) approach will be structured in our engineering curriculum by considering all factors affecting in the learning and teaching process (S. Chandrasekaran and A. Stojcevski, 2012c). From the ongoing research on project oriented design based learning, it is applicable for the School of engineering at Deakin University to motivate the students and also to teach engineering science in classrooms to get more practical experience that fulfill the industry needs (S. Chandrasekaran and A. Stojcevski, 2013b; Nelson 2004; Lehmann 2008).

The proposed approach PODBL is set have a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, and problem solving which increases student motivation and engagement. The aim of the research on PODBL approach is to develop and implement a framework for learning and teaching to solve design problems through accreditation inspired project oriented design based learning in engineering education. This research identifies the need to enhance important skills such as innovation and creativity through whole learning process that incorporates design based learning features.

The engineering teaching staff in Deakin University seems to have an adequate understanding of design based learning. This is encouraging to the School of Engineering who will enhance student learning and staff teaching process in a better way. By implementing PODBL approach in the curriculum, it helps to foster the student understanding and engagement in learning. It would be interesting task for academic staff to implement PODBL approach and integrate technology into projects in meaningful ways (S Chandrasekaran and A Stojcevski, 2013b). PODBL is bridging the gap exists between the students learning expectations and teachers teaching approach by aligning both students and staff perceptions about design focused education in their curriculum (S Chandrasekaran and A Stojcevski, 2013a; Godfrey 2009). As part of the PODBL research, the in-depth analyses of all Deakin engineering programs educational objectives, student outcomes, assessment methods and evaluation of various

* Dr Jaideep Chandran. Tel.: +61 3 52272086
E-mail address: jaideep.chandran@deakin.edu.au

undergraduate program shows that design can be learned and taught through project oriented design based learning approach in a convalescent way which is inspired by Engineers Australia accreditation requirements.

Project oriented design based learning (PODBL) in engineering education is an overarching learning approach proposed in the School of Engineering at Deakin University. It is set to satisfy many requirements of the revised accreditation criteria in Australia and around the world, as well as industrial need for the next generation engineering graduates.

1.2 Cloud Based Learning

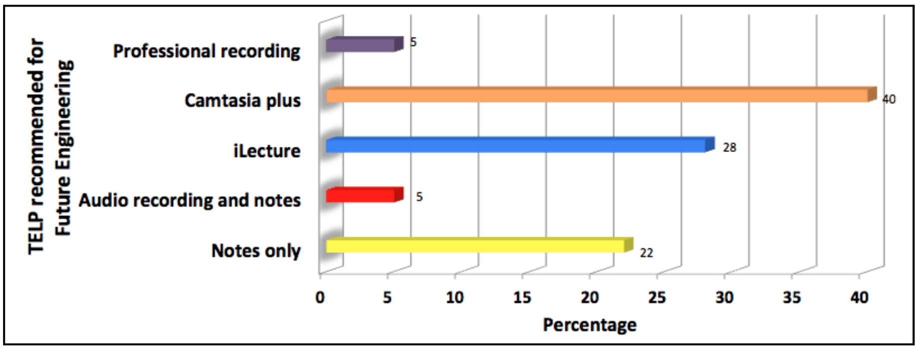

Figure 1. Technology enabled learning practices (TELP's) recommended in engineering

On 28 June 2012 the Vice Chancellor of Deakin University launched the strategic plan called LIVE the future: Agenda 2020, which bought about a major shift in the delivery for education across all disciplines. The plan focusses on Cloud and Located learning which affects every aspect of the student learning experience including the way content is delivered, assessments and student interaction and engagement with staff. This policy is designed to help Deakin University move and drive in the digital frontier a change which is moving across the education sector(John Bourne et. Al 2005). Cloud and located learning is about two distinct learning environments the first being a seamless digital environment provided on the cloud and the second focusing on the located learning experience provided on campus and learning centers and in industry settings.

The cloud learning experience for the students takes place in a digital environment where students will be able to connect with teaching staff, mentors, and have the ability to create evidence of their achievements. The cloud learning experience looks to harness new technologies to provide highly visual, media rich, interactive learning experiences to Deakin university students at locations and times which suit them. To provide this experience requires the use of new delivery platforms with education resources which are media rich and engaging. This also requires an innovative strategy in assessment and assessment pieces which will be able to provide meaningful feedback to the students.

2. Cloud learning in engineering projects

As a part of the implementation of the new cloud and located learning strategy the School of Engineering was chosen in the sandpit as one of the early implementers of this new learning and teaching philosophy. To implement this change and to meet the requirements of this new policy the school of engineering has concentrated on four areas lecture videos, eLive tutorials, cloud Deakin and industry projects.

2.1. Lecture Videos

The school of engineering uses a set of technology enabled learning practices (TELP) which included video recording of the lectures using video cameras and screen capture of the lecture slides using a software package Camtasia to deliver content to the on and off campus students. The staff in the school were encouraged to use either the screen capture software or video recording to record their lectures which provided the off campus student with an experience similar to the on campus students and in some cases blend the screen capture recordings with the video lectures. These lecture resources provide the student with an opportunity to revisit the lectures and go through the concepts discussed during the session.

A research survey was conducted to gauge the response of the students towards these offerings. The responses from the students indicated, they have found the use of audio recordings, the Camtasia recordings and video recordings helpful but when asked about which technology enabled learning practice they would recommend for the future engineering students, 40% indicated the use of a blend of screen capture and video recordings as shown in figure 1 (Joordens M, Chandran J and Stojcevski A, 2012).

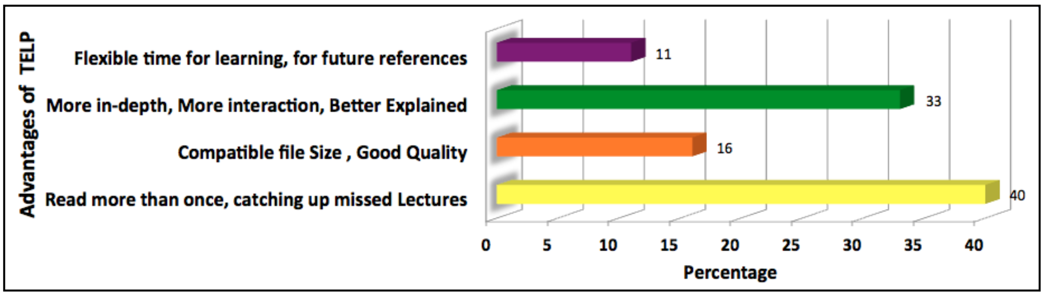

Figure 2. Student recommendations about TELP

In their recommendation for the lectures they 28 % stated it allowed them to catch up on a missed lecture and mentioned the experience being similar as attending the lecture as shown in figure 2.The download statistics for the video recording support this view; the video downloads range from 25% to 60 %. When asked to mention about the advantages of the system they indicated that there is more interaction through a technology enabled learning practice rather than the physical on site lecture, as illustrated in figure 3. This clearly shows that if technology was used to its fullest potential, interaction is certainly achievable. Another 40% indicated that the advantage of TELPs is that the lecture or learning activity can be viewed more than once and can be successfully used as a catch up exercise also shown in figure 3(Joordens Matthew, Chandran Jaideep and Stojcevski Alex, 2012).

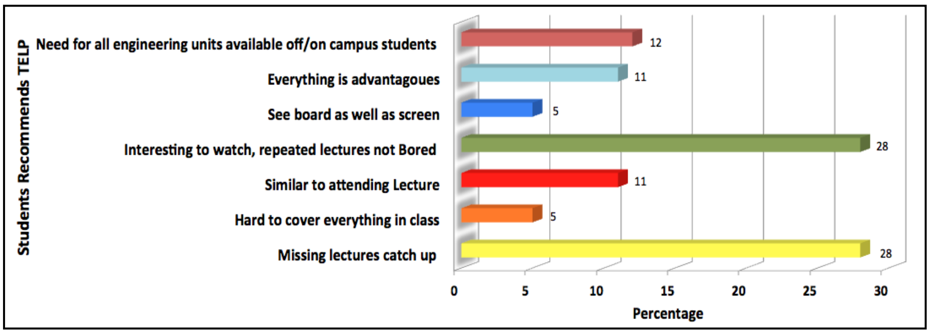

Figure 3. Advantages of TELP

2.2 Cloud Deakin

Cloud Deakin is the learning content management system for Deakin University and it is the portal which provide the students with the opportunity to interact with the staff and their peers. It is Deakin's cloud learning environment and hosts the content like the lecture notes, assignment details and the lecture videos. The cloud environment is setup to allow students and staff to interact on various topics and also students to interact within themselves. Staff members are able to provide feedback to the students and are also able to set various assessment tasks which allows for greater flexibility to the students to attempt these tasks and also allows them to maintain a record of their progress. Cloud Deakin provides the platform for students to discuss their design projects, interact with staff and peers, collect and maintain evidence on the projects.

2.3 eLive Tutorials

ElluminateLive! (eLive) is a technology resource which facilitates communication and collaboration between staff and students. It allows the staff and students to talk over the internet and also via an online chat room. It allows for students and staff to have online meetings and facilitates learning and training. Tutorials in the classroom setting allow for students to interact with the staff revisit the concepts discussed during the lectures; this scenario is replicated using eLive in a virtual setting. It presents off campus students to interact and collaborate with the staff and their peers in a safe and secure environment. Staff members can share audio and visual materials with the participants and can also invite guest speakers like experts from the industry. The flexibility of the online environment allows for the meeting to set up without the boundaries of time and space. The initiative from the school has been well received by the off campus students and also by the on campus students who use this as an extra opportunity to collaborate with the staff and their peers.

Project oriented design based learning approach focusses on this interactivity between the staff and students and among themselves and this resource provides them opportunity to interact in various setting in which members from the industry can also be invited to share their ideas and views. This resource also allows the school to provide the enhanced interaction between student and staff as mentioned in the cloud learning policy

2.4 Industry Projects

Cloud and located learning is about two distinct learning environments the first being a seamless digital environment provided on the cloud and the second is the located learning experience provided on campus and learning centers and in industry settings. Industry project allow for an enriched located learning experience which is coupled with students working on a design based project which allows them to hone their design skills and meet the learning outcome specified by the project oriented design based learning approach.

3. Integration of Cloud Learning and PODBL

The newly proposed approach, project-oriented design based learning (PODBL) is applicable to motivate the students and also to teach engineering science in classrooms to get more practical experience that fulfil the industry needs. Project-oriented design based learning is set to have a positive effect on student content knowledge and the development of skills such as innovation and creativity which increases their motivation and engagement. It is an interesting research work to develop a framework and implement a PODBL approach in meaningful ways.

3.1 The PODBL cycle

Project-Oriented Design Based Learning (PODBL) is a teaching and learning approach (TLA) that is based on engineering design activities while driven by a project. We have proposed to use PODBL at Deakin Engineering to encourage independent learning and a deep approach to learning. It is also an approach that supports the development of information literacy and design thinking in the field of tertiary education - two of the key learning outcomes in engineering these days.

There are many versions of project based learning as well as design based learning. Deakin's engineering approach is a unique combination of the two. PODBL indicates that students learn through real engineering design activities while driven by a project that has a defined deliverable, that is presented to them by industry partners or academic staff. In our version, participants work in PODBL teams of four to six members with a facilitator. The same group meets regularly throughout the trimester to work on a series of design activities. The learning and teaching delivery is a combination of cloud and located learning activities. Cloud learning enables students to evidence their achievement. Units will contain integrated short, accessible, highly visual, media-rich, interactive learning experiences rebuilt for the mobile screen, and integrating learning resources created by Deakin and other worldly universities and premium providers. Cloud learning will require students to be generators of content, collaborators in solving real world problems, and evidence their achievements in professional and personal digital portfolios. With premium cloud learning experiences in place, students who come to campus will have the opportunity to engage with teaching staff and peers in opportunities for rich interpersonal interaction through large and small team activities.

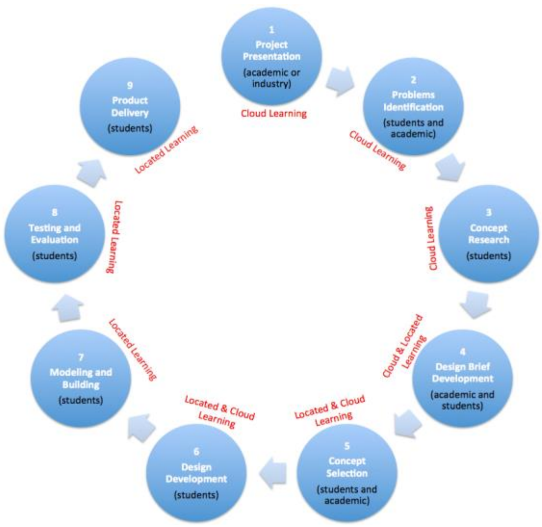

Figure 4. The PODBL learning process

The PODBL cycle involves nine main steps. The steps are illustrated in figure 4 above and described below. Steps 1-3 take place in the cloud, step 4-6 are a combination of both cloud and located learning, and steps 7-9 are performed through located learning.

Step 1: Project Presentation

The project is presented to the team of students by the industry client (if project is industry based) or by the academic facilitator if the team if the project is university based. The project outline, which is usually open-ended, is about half in length. It is recommended that one member of the student's team reads the project outline aloud to the group without comment at this stage.

Step 2: Problems Identification

This step is all about brainstorming the project. The student team could ask the following questions:

What do we know about this problem outlined in the project brief?
What do we need to find out about the problem?
What are the significant issues (teaching, learning, technical, social, economic and political)?
What do we need to learn?
What are the priorities? What is most important to learn?

The rules of brainstorming are that no evaluative comment is allowed at this stage. The aim is simply to get as many issues on the board or the cloud as possible so that they can be prioritised, spilt/clumped, and researched in the next step. One person in the group needs to be identified to act as scribe and write issues as they are raised.

Step 3: Concept Research

The first activity that needs to take place as part of this step is to identify, discuss, and assign the learning issues to each and every member of the team. Once this is done, each student in the team undertakes research into the assigned learning issue. Some of the questions that may arise could be:

What are the essential learning issues (for everyone to follow up)?
What are the specific learning issues (for individuals to follow up)?
What resources are available?
Who will look up what (and report back to the team)?
What are the overlapping issues?

Each member of the team needs to understand what all members of the team have agreed to research and what them as individuals must contribute to the team. As students locate resources that are directly relevant to the learning issues, the other members of their PODBL team need to be advised by posting a message in the appropriate discussion forum on the cloud.

This message must include enough information to allow others to locate the resource (for books and journals, bibliographic details; for Web resources, the URL or Web address); a brief summary of the content of the resource - cutting and pasting the abstract of a paper is often useful; and a comment on why they believe the resource is relevant to the learning issue. In some cases, a digital copy of the document itself may be attached but this should be done without breaching the copyright law and for this reason, it is not recommended to attach copies of scanned chapters of books.

As these resources accumulate and members of the team use the online discussion tool to comment on and ask questions about the resources. Online discussion is an assessed task, with marks allocated on the basis of the quality and quantity of contributions by each participant.

Step 4: 'Design Brief' Development

The 'design brief' is the key project planning document that specifies what the project has to achieve, by what means, and within what timeframe. During this step, the team of students uses the concept research ideas and findings to develop the 'design brief'.

Step 5: Concept Selection

By evaluating the research findings performed in step 3, during this step the team decides and selects the most appropriate concept to be used in order to develop their final design.

Step 6: Design Development

During this step the student team uses the selected concept in step 6 to finalise and develop their final design. This could include new ideas and additional features on top of the selected design.

The development of the design brief, the selection of the concept and the development of the final design form in step 4 to 6 form key components of the assessment pieces and the student portfolio which evidences their achievement; this portfolio is maintained digitally on the cloud which allows students to share evidence of their achievements with prospective employers and also reflect on their achievements. This allows us to provide the students with assessment tasks linked to real world situations and an opportunity to receive meaningful feedback a key principle of cloud learning.

Step 7: Modelling and Building

During this step the student team models and/or builds their design. Depending on the engineering stream this could be done using hardware equipment, modelling software, and laboratory equipment.

Step 8: Testing and Evaluating

Once the design has been modelled and/or built, the team tests it and evaluates it against the set requirements and specifications. Laboratory equipment or industry tools could be used to do this.

Step 9: Product Delivery

The last step in the PODBL cycle is product delivery. This is when the student team presents their final product to the academic and/or industry member(s). The final product can be in the form of a hardware, software, presentation, report, and other deliverables as set and agreed on by the team and the facilitator at the start of the project. The final product is assessed based on an agreed rubric.

4. Conclution

Project-oriented design based learning (PODBL) is a model designed to motivate students and teach engineering in a way that is student-centered and project driven. The cloud and located leaning experience is a convergence of experience provided on the cloud in a seamless digital environment with assessments linked with tasks performed by student in their chosen professions and opportunities to interact with staff and peers through located learning. The PODBL model integrates cloud and located learning, which allows students to learn through design activities on the cloud and in the interactive classroom. Project-oriented design based learning is set to have a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, creativity, innovation, and problem solving which increases their motivation and engagement.

References

Bourne, J., Harris, D., & Mayadas, F. (2005). Online engineering education: Learning anywhere, anytime. *Journal of Engineering Education*, *94*(1), 131-146.

S Chandrasekaran and A Stojcevski, G Littlefair, M Joordens. (2013a). *Alinging Students and Staff Perspectives in Design Curriculum.* Paper accepted at the Proceedings of the Research in Engineering Education Symposium 2013, Kuala Lumpur.

S Chandrasekaran and A Stojcevski, G Littlefair, M Joordens. (2013b). *Project Oriented Design Based Learning - Staff Perspectives*. Paper accepted at the The 4th International Research Symposium on Problem-Based Learning (IRSPBL) 2013, Malaysia.

S.Chandrasekaran and A.Stojcevski, G.Littlefair, M.Joordens. (2012a). *Learning through Projects in Engineering Education*. Paper presented at the 40th SEFI Annual Conference 2012, Thessaloniki, Greece.

S.Chandrasekaran and A.Stojcevski, G.Littlefair, M.Joordens. (2012b). The Process of Design Based Learning: A Students' Prespectives. *Australasian Association for Engineering Education (AAEE) Annual Conference 2012*.

S.Chandrasekaran and A.Stojcevski, G.Littlefair, M.Joordens. (2012c). Project Oriented Design Based Learning: Aligning Students' Views with Industry needs. *International Journal of Engineering education*.

Doppelt, Y. (2009). "Assessing creative thinking in design-based learning." International Journal of Technology and Design Education.

Godfrey, E., Hadgraft, R., (2009). "Engineering Education Research: Coming of age in Australia and New Zealand." Journal of Engineering Education.

Joordens, Matthew, Jaideep Chandran, and Alex Stojcevski. "Comparison of Technology Enabled Learning Practices (TELP) in engineering: a student's perspective." *AAEE 2012: The profession of engineering education, advancing teaching, research and careers: Proceedings of the 23rd Annual Conference of the Australasian Association for Engineering Education*. ESER group, Swinburne University of Technology.

Lehmann, M., Christensen, P., Du, X., Thrane, M., (2008). "Problem-oriented and project-based learning (POPBL) as an innovative learning strategy for sustainble development in engineering education." European Journal of Engineering Education.

Nelson, D. (2004) "Design Based Learning Delivers Required Standards in all Subjects, ." K12. Journal of Interdisciplinary Studies.

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The Relationship Between Conceptions of Teaching and Learning and Perceptions of Problem-Based Learning among Physics Faculty

Brian Bowe *,

College of Engineering & Built Environment, Dublin Institute of Technology, Bolton St, Dublin 1, Ireland

Abstract

This paper presents findings from research that examined the relationship between physics faculty conceptions of teaching and learning and their perceptions of problem-based learning as an appropriate pedagogical approach in physics education. The introduction of problem-based learning in physics is often met by significant resistance and opposition. One of the reasons often cited for this opposition, is epistemological beliefs, and hence conceptions of teaching and learning, of the physics educators that are not aligned to student-centered learning. This paper examines these conceptions and discusses the implications for the use of problem-based learning in physics education.

Keywords: Conception of teaching and learning, physics, phenomenography

1. Introduction

Although problem-based learning (PBL) is now widely used as an educational approach in many different disciplines its use in physics education is a relatively recent development (Walsh et al., 2007). Although, research has shown the benefits of the student-centred and constructivist nature of PBL there appears to be a reluctance to introduce PBL into physics courses. This is possibly due to the pedagogical view that the students require a sound body of knowledge and mathematical skills before they are equipped to engage with a problem-solving process (Bowe and Cowan, 2004). Within the PBL environment it is through group-based problem-solving activities that the students develop their knowledge and conceptual understanding. Hence, it can be seen as the exact opposite of the traditional pedagogical approaches found in most science courses, where the knowledge is given before the students have opportunities to apply and problem solve. If PBL is to be widely implemented in physics education, it has to be widely adopted by physics lecturers. However, as Kember (1997) and Kandlbinder and Mauffette (2001) reported, successfully adopting the PBL approach requires lecturers having student-centred conceptions of teaching whereby teaching is viewed as a means of facilitating understanding and conceptual change and development. Savin-Baden's (2003) research also highlights the importance of the lecturers' epistemological perspectives in determining the model of PBL. O'Grady (2004) argued that educators must not ignore the difficult yet fundamental epistemological questions that underpin PBL. Failing to do so can lead to a model of PBL which is not student-centred and hence does not achieve the potential benefits of a group-based problem-driven learning environment. Research by Ramsden (1991) that examined the differences in teaching approaches between various disciplines revealed that science lecturers are more likely to use formal, didactic teaching methodologies and that they are less open in their attitudes towards student learning. In addition, research by Trigwell et al. (1999) revealed that those who conceive of teaching as transmitting information to students would see little use in posing problems for students to comprehend. Finally, in research by Ching and DeGallow (2002) it is argued that in order to successfully adopt PBL, lecturers not only need to be enthusiastic but they also must show willingness to fundamentally change their teaching practices.

In short, for lecturers to adopt PBL they need to be enthusiastic, willing to change their teaching practices and have a student-centered conception of teaching but unfortunately, research has shown that many science lecturers tend not to have the necessary student-centered conception of teaching (Ramsden, 1991b). Therefore, in order to make informed decisions to introduce PBL, and if so to what extent and what model, requires being able to determine lecturers' conceptions of learning and teaching and knowing how these, and other factors, will determine their teaching approaches. This research examined the conceptions of teaching and learning of physics faculty in departments where PBL courses had been introduced and investigated the relationship between these conceptions and their perceptions of PBL. The implications these findings have for the use of PBL in physics education is discussed.

* Corresponding Author name. Tel.: +00-353-1-4023616
E-mail address: brian.bowe@dit.ie

2. Conception of Teaching and Learning

In one of the earliest studies of lecturers' conceptions of teaching from the student learning perspective, Dall'Alba (1991) interviewed 20 teachers from the fields of economics, English, medicine and physics in Australian universities. She identified seven different ways in which those teachers conceived of or understood their teaching in their particular teaching and learning situations:

1. Teaching as presenting information;
2. Teaching as transmitting information (from teacher to students);
3. Teaching as illustrating the application of theory to practice;
4. Teaching as developing concepts / principles and their relations;
5. Teaching as developing the capacity to be expert;
6. Teaching as exploring ways of understanding from different perspectives;
7. Teaching as bringing about conceptual change.

Martin and Ramsden (1993) later suggested that the more complete conceptions are associated with a lecturer whose awareness has been expanded to not only include himself/herself but also the students' understanding of the content. Research carried out by Prosser et al. (1994) identified six conceptions of teaching:

1. Teaching as transmitting concepts of the syllabus;
2. Teaching as transmitting the teacher's knowledge;
3. Teaching as helping students acquire concepts of the syllabus;
4. Teaching as helping students acquire teacher's knowledge;
5. Teaching as helping students develop conceptions;
6. Teaching as helping students change conceptions

In research by Linder and Marshall (2003) three conceptions were characterized among physics lecturers who saw the purpose of their teaching as:

1. The promotion of metacognition as a way of exploring conceptual understanding;
2. The transfer of theoretical content as a framework for learning to successfully solve physics problems;
3. The promotion of a coherent view of content as a way of avoiding an "applied mathematics approach".

Prosser et al. (1994) also identified five conceptions of learning:

1. Learning as accumulating information to satisfy external demands;
2. Learning as acquiring concepts to satisfy external demands;
3. Learning as acquiring concepts to satisfy internal demands;
4. Learning as conceptual development to satisfy internal demands;
5. Learning as conceptual change to satisfy internal demands.

Their research revealed that teachers who hold a conception of teaching as the transmission of information, with little or no focus on the students or their understanding, also hold a conception of learning as students accumulating more information rather than developing and changing their conceptions and understanding. Similarly, teachers who hold the more complete conceptions of teaching also hold a more complex understanding of learning.

Trigwell et al. (1994) carried out research to examine the variations in the way lecturers approach their teaching. They identified five different approaches to teaching, which were constituted in terms of the teachers' intentions and strategies:

1. A teacher-focused strategy with the intention of transmitting information to students;
2. A teacher-focused strategy with the intention that students acquire the concepts of the discipline;
3. A teacher-student interaction strategy with the intention that students acquire the concepts of the discipline;
4. A student-focused strategy aimed at students developing their conceptions;
5. A student-focused strategy aimed at students changing their conceptions.

Trigwell and Prosser (1999) went on to relate these five approaches to teaching to the lecturers conceptions of teaching and learning. They showed that teachers who adopted a student-focused approach to their teaching of a topic conceived of their teaching and learning in more complete ways, for instance as conceptual change and development. Teachers who approached their teaching from a teacher-focused perspective conceived of their teaching and their students learning in less complete ways, for instance as information transmission.

3. Research Methodology

The research is situated in a set of epistemological beliefs and assumptions termed "constitutionalism" (Marton and Booth, 1997), which is similar to the more commonly known constructivist perspective in that they both view meaning as something that is not discovered, but constructed. Trigwell and Prosser (1996) argue that this perspective is the most appropriate from which to situate research that examines students' or teachers' conceptions of teaching and learning. Students and teachers will not all experience the same learning and teaching situation in the same way nor will they approach their learning or teaching in the same way, even within the same context. From this constitutionist perspective, I chose a phenomenographic research methodology that would serve as a framework in which I could investigate physics lecturers' conceptions of learning and teaching, approaches to teaching, and their perceptions of PBL as a pedagogical approach. Phenomenography is an empirical research methodology that was designed to answer questions about thinking and learning, especially in the context of education research (Marton, 1986). It is concerned with the relationships that people have with the world around them and aims to elucidate the different possible conceptions that people have for a given phenomenon. In the phenomenographic approach the objective is to find out the qualitatively different ways of experiencing or thinking about the same phenomena. It assumes that there are a limited number of qualitatively different ways in which different people experience a certain phenomenon (Marton, 1994). These are then characterised in terms of categories of description, related to each other and forming hierarchies in relation to a set of criteria – "outcome spaces".

3.1. Data Collection & Analysis Methods

Although different research methods have been used in the phenomenographic methodology, the dominating method has been the open and deep interview, which is carried out in a dialogical manner (Booth, 1997). In order to choose the interview participants, the physics lecturers were asked to complete the Approaches to Teaching Inventory (ATI). Prosser and Trigwell (1999) developed the ATI as an instrument to "measure the ways teachers approach their teaching" (p.176) in a particular context. It evolved from their phenomenographic research (Prosser et al., 1994; Trigwell et al., 1994) and therefore, in a sense, it already assumes the categories within the outcome space. The inventory examines whether a lecturer teaches, or at least intends to teach, for conceptual change or information transmission and whether that lecturer adopts a student-focused or a teacher-focused approach in a particular context. In the research presented in this paper, each physics lecturer completed at least one inventory but in a number of cases they completed two, as the responses to the inventory are relational and specific to the context. The aim of the interviews was then to have the participant reflect on his or her experiences and then relate those experiences to me in such a way that both of us came to a mutual understanding about the meanings of the experiences, or of the accounts of the experiences. In a sense the interviews also provided me with the opportunity to ask follow-up questions from the ATI. Without the interviews, I would not have had access to the lecturers' conceptions, perceptions and understanding, which only emerged from the extensive interview discussions. During data analysis, I sought to identify qualitatively distinct categories that described the lecturers' perceptions, conceptions and approaches. I believed that a limited number of categories were possible for each research question and that these categories would be discovered by immersion in the data. I examined the transcripts of the participants' interviews, looking both for similarities and differences among them. In this process, I developed initial categories that described their experiences, concepts and experiences of the different phenomenon. I developed an outcome space, for each topic while ensuring internal consistency and parsimony. Once I had defined the stable outcome spaces I then considered how the individual categories relate to each other and how the outcomes spaces relate to each other.

3.2. Research Participants

In all 31 physics lecturers from two higher education institutes participated in this research. In these institutes, the PBL elements were extensive and there were proposals to increase its use further.. To ensure reliability in the findings, I felt it was necessary to involve as many lecturers as possible and to ensure there were a variety of profiles. There were 6 PBL tutors among the 31 physics lecturers and 8 lecturers who were openly opposed to the introduction of PBL. The conceptions and perceptions of 15 of these physics lecturers were examined in interviews. The lecturers were selected, after the ATI data were analyzed, to include a range of profiles, as shown in Table 1.

Table 1. Number of lecturers interviewed in each sub-scale of the Approaches to Teaching Inventory

Sub-scales	Student-focused	Teacher-focused	Unclear Strategy	TOTALS
Conceptual Change	3	0	2	5
Information Transmission	0	3	2	5
Unclear Intention	0	3	2	5

TOTALS	3	6	6	15

4. Findings

4.1. Conceptions of Teaching

The analysis of the interview data revealed that physics lecturers appear to hold qualitatively different conceptions of teaching. It also revealed that a lecturer might hold a conception of teaching in one environment and a different conception in another. However, it was the lecturers' predominant conceptions of teaching in lecture-based courses (including lectures, tutorials and laboratories) that were examined or to be more specific the lecturers were questioned about the purpose of their teaching. An outcome space emerged from analysis of the data that describes 4 different ways in which the physics lecturers conceived of their teaching in lecture-based courses, as summarized in Table 2. The numbers in the brackets in Table 2 represent the number of lecturers in that category who are either PBL tutors (PBL) or who are opposed to the use of PBL (Opp.).

Table 2. Outcome space that describes the different ways lecturers conceive of teaching in lecture courses

	Categories of Conceptions of Teaching	Number of Lecturers	
A	Teaching as presenting the correct information (facts, equations, knowledge) necessary to prepare the students for assessments and the workplace	**6**	(4 Opp.)
B	Teaching as transmitting the information in order for the students to develop conceptual understanding and problem-solving skills at a later stage	**4**	(1 PBL)
C	Teaching as explaining the lecturer's knowledge and understanding in order that the students can develop an understanding of physics and problem-solving skills	**3**	(1 PBL)
D	Teaching as providing the students with opportunities to develop conceptual understanding and problem-solving skills	**2**	(2 PBL)

Lecturers in Category B hold a very similar conception of teaching as those in Category A, in that they both see teaching as presenting, or transmitting, the information to the students. However the lecturers in Category B transmit this information to their students so that they can develop conceptual understanding and problem-solving skills at a later stage. There is disagreement on exactly when this stage is, as some felt this would happen in later stages of the course and others felt this happened in the workplace. However, they agreed it was not their responsibility and was therefore not the purpose of their teaching. Lecturers in Category C view the purpose of teaching as helping the students develop an understanding of physics and problem-solving skills but they feel this can be achieved by explaining their knowledge and understanding to the students. Therefore, although categories A, B and C differ in purpose, they are all essentially teacher-focused conceptions of teaching that emphasis presenting, transmitting and explaining information and knowledge. Lecturers in Category D conceive of teaching in a more student-focused way, in that they view the purpose of teaching as providing the students with opportunities to develop conceptual understanding, problem-solving skills and laboratory skills. It is interesting to note that only 2 of the 4 PBL tutors saw the purpose of teaching as providing the students with these opportunities. However, when asked about the purpose of teaching in their PBL courses, all 4 tutors fall into Category D, using words such as "facilitate", "guide" and "tutor" to describe their teaching approach. One tutor suggested a reason for this change of approach:

> "It is not that I go in (to the PBL tutorial) consciously thinking about developing their conceptual understanding, it is just what happens because the system is set up to support this type of learning…The PBL process, small groups, interesting problems, it is not like I decide not to give a lecture, it just wouldn't be appropriate in that situation. Just as PBL is not appropriate when I have to teach 60 first year students, on my own, in a lecture hall."

From the analysis of their conceptions of teaching, it was possible to make the following points:

- The majority of physics lecturers interviewed conceive of teaching primarily as a way of transmitting, presenting, explaining and demonstrating the correct information, theory, knowledge or understanding;
- A small minority conceive of teaching as a means of providing the students with opportunities to develop conceptual understanding and problem-solving skills;
- Teacher-focused conceptions of teaching are strongly related to prioritizing content coverage when designing lessons;
- All 4 lecturers opposed to the use of PBL hold teacher-focused conceptions of teaching (presenting/demonstrating) and see content coverage as the priority;

4.2. Conceptions of Learning

Table 3 shows the outcome space that describes the two different ways in which the physics lecturers conceive of their students' learning.

Table 3. Outcome space that describes the two different ways lecturers conceive of their students' learning.

	Categories of Conceptions of Learning	Number of Lecturers	
A	Learning as the accumulation of facts, theories, principles and skills as demonstrated, presented and explained by the lecturer	**10**	(1 PBL, 4 Opp.)
B	Learning as the development of an understanding of the conceptual nature of physics	**5**	(3 PBL)

In the interviews, the lecturers were also asked about their students' approaches to learning and specifically what they perceive as the factors that affect their students' approaches to learning. First, the lecturers were asked to describe the approaches to learning they perceive their students adopt. Table 4 shows the three different categories of perceptions: a number of lecturers described an approach that can be described as a 'surface' approach, while others described an approach that can be described as a 'deep' approach and there were also a number of lecturers who had no perception of the their students' approaches to learning.

Table 4. Outcome space that describes the approaches to learning the lecturers perceive their students adopt.

	Categories of Perceptions of Student Approaches to Learning	Number of Lecturers	
A	Students adopt a surface approach	**4**	(1 PBL)
B	Students adopt a deep approach	**8**	(3 PBL, 2 Opp.)
C	Have no perception of what approach their students take	**3**	(2 Opp.)

Of the 8 lecturers who feel their students adopt a deep approach, 5 conceived of learning as the development of an understanding of the conceptual nature of physics and felt this could only be achieved if the students adopted a deep approach. However, for 2 of these 5 lecturers there was a distinct lack of understanding of the affects many aspects of the learning environment have on their students' approaches to learning. This lack of understanding was also prevalent among the other 3 lecturers who perceived their students as 'deep' learners but conceived of learning as the accumulation of information. From the analysis of their conceptions of learning, it was possible to make the following points:

- The majority of these physics lecturers view learning as accumulating knowledge with a minority viewing learning as the development of conceptual understanding;
- The lecturers opposed to PBL view learning as the accumulation of knowledge and all but one of the PBL tutors see learning as the development of conceptual understanding;
- The majority of lecturers feel that their students adopt a deep approach to their learning but half of these lecturers did not see assessment as playing a major role in determining the students' approaches to learning;
- The majority of lectures perceive the nature and relevance of the course material as having a greater role than assessment in determining their students' approaches to learning.

4.3. Perceptions of Problem-based Learning

The interviews examined the lecturers' perceptions of PBL as a pedagogical approach in physics education. There was a wide range of perceptions as attitudes PBL varied from enthusiasm to tolerance to opposition. In the analysis I initially excluded the perceptions of the PBL tutors and organized the remaining perceptions into three categories: positive, negative and neutral. Table 6 shows these categories with the perceptions in each and it should be noted that a lecturer may be opposed to the introduction of PBL but may still have positive perceptions of it. For instance, a lecturer may feel PBL has pedagogical benefits but may also feel that it is far too resource intensive. Equally, a lecturer who is supportive of PBL may also have some negative perceptions. The perception that PBL requires much more work by the lecturer and more resources was prevalent among both the physics lecturers who supported the use of PBL and those against it. For instance, Lecturer W who was not a PBL tutor but supported the use of it in physics education stated:

> "I like the idea of using PBL, it seems to mirror the research learning process. We all know that students learn more doing their final year project than in all the previous years but I just do not have the time to redesign my course. I'm not going to do it unless I can do it properly and my current research commitments do not make that possible."

Table 6. Outcome space that describes the different ways lecturers perceive of PBL

Category	Perception
Positive	• It is a student-centred approach that supports the development of conceptual understanding, problem solving skills and other key skills • It models the learning that occurs in the research process and it is therefore more effective than passive learning
Negative	• It is not a suitable approach for the physical sciences, as they are conceptual subjects that cannot be taught through this approach • It slows the learning process and therefore it is not possible to cover the required and necessary content • It is only suitable for developing problem-solving skills with students who already have the required knowledge • It concentrates more on the development of skills that are not necessary to be a physicist • It requires far too many resources and too much effort on the part of the lecturers • It is just the current fad and will not last
Neutral	• It is a better approach than the traditional approach but it requires extra resources and effort • It predominantly works because of the social dimension but it would be less resource intensive to simply introduce more group activities • It requires far too much work and resources and therefore its use will fade out

There was also a mistrust of the approach due to the fact that it is a 'new' approach and hence there was little evidence of its benefits. From those opposed to the use of PBL in physics education, the following quotes were typical:

> "It is not my job to worry about group, communication, presentation skills and so on. My job is to teach physics, the students come here to learn about physics. I think we are forgetting what we are here to do."

> "If we can't cover 100% of the curriculum using PBL, then we shouldn't even be contemplating using it. We are just making everything easier for the students. from the style menu. Insert your heading text and choose the appropriate heading level from the style menu."

4.3.1. Tutors' Perceptions of PBL

The PBL tutors' perceptions were also examined. Their perceptions were relational, in that the tutors tended to compare the PBL approach to a traditional lecture-based course. For instance, it can be seen from Table 7 that the tutors perceive PBL as requiring extra staff time, along with other additional resources, such as laboratory equipment and adequate learning resources. Indeed, all tutors felt that there are extra resources needed to run the PBL course as compared to a course taught in a traditional format, in particular time and equipment.

Table 7. Outcome space that describes the different ways tutors perceive of PBL

Category	Perception
Positive	• It is a student-centred approach that supports the development of conceptual understanding, problem solving skills and other key skills • It models the learning that occurs in the research process and it is therefore more effective than passive learning • It supports the development of key skills • It is much more enjoyable than lecturing • It allows the tutors to observe the learning process
Negative	• It requires a great deal of extra time, particularly in the development stage, but also to assess and to give feedback • It is not feasible with large numbers

4.4. Relationships between the conceptions of teaching and learning and perceptions of PBL as a pedagogical approach in physics education

The findings from this study revealed that the majority of lecturers held both positive and negative perceptions of PBL. The research revealed that there are a small minority of lecturers adamantly opposed to PBL and only hold negative perceptions of it as a pedagogical approach in physics education. There are an approximately equal number of lecturers who are fully supportive of it and hold predominantly positive perceptions. The remaining lecturers tend to have mixed perceptions and see its potential benefits while at the same time recognizing its disadvantages. For instance, many of these lecturers see its pedagogical advantages but see it as impractical in terms of resources and time. Table 8 summarizes the findings from the outcome spaces. Those lecturers who believe that the purpose of teaching is to transmit information feel PBL is a waste of resources, inefficient and totally unnecessary. Categories C and D may also include lecturers opposed to PBL but the reasons tend to be associated with time and resources and the fear that committing to such an initiative would take from their other interests and activities.

Table 8. Summary of Findings aligned the outcomes spaces

Cat.	Conception of teaching	Conception of learning	Teaching Approach	Environment Affects Approach	Perception of PBL
A	Facilitating learning	Development of conceptual understanding	Student-focused	No	Positive
B	Transmitting information	Accumulation of knowledge	Teacher-focused	No	Negative
C	Facilitating learning	Development of conceptual understanding	No clear approach or teacher-focused	Yes	Mixed
D	Changes depending on teaching context	Changes depending on teaching context	No clear approach or teacher-focused	Yes	Mixed

The lecturers involved in this research study came from two higher education institutes where PBL had been introduced into physics education. In each institute it was introduced by a small number of 'early adopters' (from Category A in Table 8) and there has been a minority of lecturers opposed to the use of PBL (from Category B). However, the lecturers involved in the PBL courses have sought to persuade their remaining colleagues (categories C and D) to get involved in the PBL courses. These lecturers may adopt predominantly teacher-centred approaches but there may be strategies that can be used to persuade them to move towards more student-centred approaches. From the study of the physics lecturers' teaching approaches, conceptions of teaching and learning and their perceptions of PBL, the following statements can be made:

- The majority of lecturers adopt teacher-focused approaches as opposed to student-focused approaches;
- The majority of lecturers have the intention of teaching for information transmission as opposed to conceptual understanding;
- Their teaching contexts influence the majority of lecturers' conceptions of learning and teaching;
- Lecturers' conceptions of learning and teaching affect their approaches to teaching;
- The majority of lecturers have positive perceptions of PBL but see it as resource intensive and are unsustainable;
- The majority of lecturers do not feel their teaching contexts are appropriate to support the use of student-centered learning approaches;
- There is only a minority of lecturers with firm conceptions of teaching and learning as transmitting information and the accumulation of knowledge respectively;
- There is a minority of lecturers with firm conceptions of teaching and learning as facilitating learning and the development of conceptual understanding respectively;
- There is lack of an awareness of the roles assessment and workload play in determining student approaches to learning.

5. Discussion

Previous studies have suggested that the successful introduction of PBL requires lecturers, with student-centred concepts of learning and teaching, who adopt student-focused teaching approaches. Even though this study revealed that the majority of lecturers adopt teacher-focused approaches and have teacher-focused conceptions of teaching, it also showed that the lecturers' conceptions of teaching are influenced by their teaching contexts and their approaches to teaching vary accordingly. Furthermore, only a minority of lecturers hold steadfast teacher-focused conceptions of teaching and hence use teacher-focused approaches to teaching and these lecturers see PBL as inefficient and ineffective. In order to successfully adopt PBL, lecturers must show a willingness to fundamentally change their teaching practices and this research showed that teaching practices can be changed from teacher-focused to student-focused if the lecturers perceive their teaching contexts support these types of approaches. For instance if the class sizes are not too large, academic workloads are not too great and the lecturers have control over what and how they teach. In these conditions, lecturers who currently use teacher-centred approaches may move towards more student-centred approaches to support the development of conceptual understanding and problem-solving skills. The findings would seem to support Biggs (2003) when he stated that the reasons why PBL is not more widely used are not educational but organisational. However, even if these lecturers do begin to adopt student-centred approaches that does not inherently mean they will adopt PBL as a pedagogical approach. Marincovich's (2000) suggested that PBL goes against the 'grain' of lecturers who are mostly devoted to their discipline, eager to dispense knowledge and content-oriented and Perrenet et al. (2000) stated that in order for a pedagogical innovation to be successfully adopted it must reflect the nature of the profession. PBL does not necessarily reflect the way in which a physicist would work nor is it perceived as developing knowledge of theories or principles. However, if the model of PBL is changed to better reflect the type of learning that occurs during research it may be better accepted among physicists. Similar to a research project, PBL simply involves posing a problem before the students have learned the necessary knowledge. The problem tends to motivate the students and then know why they are learning, in the same way as the final year students do when working on their projects. If PBL is portrayed in this light and developed so that, as Miflin (2001) suggests, both types of lecturer, the student-centred and the more didactic type, have roles to play in the PBL curriculum its use may increase in physics education. However, as mentioned previously, if student-centred approaches such as PBL are to be accepted, the priority in curriculum and lesson design cannot be content ceverage as it is not possible to 'cover' the same amount of content with these approaches as it is with didactic appoaches. One model that may be more favourably adopted by physics lecturers, namely, project-based learning (Blumenfeld et al., 1991). This does share some similarities to PBL in that the students work in groups on projects and they can have the same roles and be assessed in the same way as in the PBL approach. However, in project-based learning the group project work runs parallel to a series of lecturers where the knowledge they need to successfully complete the project can be obtained. Therefore the pedagogical emphasis of project-based learning is to integrate and apply the knowledge gained through the lectures, while in PBL the emphasis is also on the acquisition of knowledge and understanding. So although the problem, or project, drives the acquisition of knowledge the students can get this from traditional lectures. This has been widely accepted in engineering education (Mills and Treagust, 2003; Perrenet et al., 2000), which has many similarities with applied physics. Perhaps, if PBL continues to be introduced and used in physics education, the model will continue to evolve to better suit the discipline and the epistemological beliefs of the lecturers.

References

Barrows, H. S. and Tamblyn, R. M. (1980), *Problem-based Learning, An approach to Medical Education,* New York, Springer.

Biggs, J. (2003), *Teaching for Quality Learning at University: What the Student Does*, 2nd edn., Maidenhead, SHRE/Open University Press.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991), Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, 26 (3 & 4), 369-398.

Booth, S. A. (1997), On Phenomenogrpahy, learning and teaching, *Higher Education Research and Development*, 16, 135-159.

Bowe, B. and Cowan, J. (2004), *A comparative evaluation of problem-based learning in Physics: A lecture-based course and a problem-based course*, in Challenging Research into Problem-based Learning, Savin-Baden, M. and Wilkie, K. (eds) SRHE / Open University Press

Ching, C. C. and De Gallow (2002), *Fear and loathing: Faculty reactions to developing problem-based learning for a large research university*, Proc. PBL 2002 - A Pathway to Better Learning, Baltimore, USA.

Dall'Alba, G. (1990), Foreshadowing Conceptions of Teaching, Research and Development in Higher Education, 13, 293-297.

Kandlbinder, P., Mauffette, Y. (2001), Perceptions of Teaching by Science Teachers using a Student-Centre Approach, *in The Power of Problem-based Learnin*g, Little, P. and Kandlbinder, P. (eds), Proc. of the 3rd Asia Pacific Conference on PBL, 9-12 December.

Kember, D. (1997), A reconceptualisation of the research into university academics' conceptions of teaching, *Learning and Instruction*, 7, 255-75.

Linder, C. J, and Marshall, D. (2003), *Teaching Focus in Higher Education Physics and Students' Conceptions of Good Teaching: a relational perspective*, Conf Proceedings European Science Education Research Association, Netherlands.

Marincovich, M. (2000), Problems and promises in problem-based learning, in O. S. Tan, P. Little, S. Y. Hee, and J. Conway, (eds), *Problem-based Learning: Educational Innovation Across Discipline*s, Singapore: Temasek Centre for Problem-based Learning.

Martin, E and Ramsden, P. (1993), An expanding awareness: how lecturers change their understanding of teaching, *Research and Development in Higher Education*, 15, 148-155

Marton, F. (1986), Phenomenography - a research approach to investigating different understandings of reality, *Journal of Thought*, 21, 28-49.

Marton, F. (1994), Phenomenography. In T. Husen & T. N. Postlethwaite (Eds.*), The international encyclopaedia of education* (2nd ed., Vol. 8, pp. 4424–4429). Oxford, U.K.: Pergamon

Marton, F. and Booth, S. (1997), *Learning and Awareness*, Maywah, New Jersey, Lawrence Erlbaum.

Miflin, B. (2001), Mediating a leap of faith: Lessons from the experience of preparing teachers for problem-based learning, in *The Power of Problem-based Learning*, Little, P. and Kandlbinder, P. (eds), Proc. of the £rd Asia Pacific Conference on PBL, 9-12 December.

Mills J. E., and Treagust, D. F. (2003), Engineering Education - Is Problem-based or Project-based learning the answer? *Australasian Online Journal of Engineering Education*, http://www.aaee.com.au/journal/online.htm

O'Grady, G., (2004), The Dangers of PBL (and other instructional fads): Beware the epistemological hole in the practice of PBL. Paper presented at the PBL 2004 Conference, Cancun, Mexico

Perrenet J. C., Bouhuijs P. A. J., Smitts J. G. M. M. (2000), The Suitability of Problem-Based Learning for Engineering Education: theory and practice, *Teaching in Higher Education*, 5 (3), 345-358.

Prosser, M., Trigwell, K., and Taylor, P. (1994), A phenomenographic study of academics' conceptions of science learning and teaching, *Learning and Instruction*, 4, 217-231.

Prosser, M., and Trigwell, K. (1999) *Understanding Learning and Teaching: The experience of higher education*. SRHE and Open University Press, Buckingham.

Ramsden, P. (1991), Context and Strategy: situational influences on learning, in *Learning Strategies and Learning Styles*, Schmeck, R. R. (ed.) 159-184, Plenium Press, New York.

Ramsden, P. (1991b), A performance indicator of teaching quality in higher education: the course experience questionnaire, *Studies in Higher Education*, 16(2), 129-150

Savin-Baden, M. (2003), Facilitating *Problem-based Learning- Illuminating Perspectives*, Open University Press/SRHE, Buckingham.

Trigwell, K. and Prosser, M. (1996), Congruence between intention and strategy in science teachers' approach to teaching, *Higher Education*, 32, 77-87.

Trigwell, K, Prosser, M. and Taylor, P. (1999), Relations between teachers' approaches to teaching and students' learning, *Higher Education*, 37, 57-70.

Trigwell, K. and Prosser, M. (2004), Development and use of the Approaches to Teaching Inventory, *Educational Psychology Review*, 16(4), 409-424.

Walsh, L.N., Howard, R.G. & Bowe, B. (2007), Phenomenographic study of students' problem solving approaches in physics, Phys. Rev. S T Phys. Educ. Res. 1, 020108

Design Studio as Problem Based Learning in Architectural Education in Universiti Teknologi Malaysia

Fa'izah Mohammed Bashir [a] *, Mohd Hamdan Ahmad [b], Malsiah Hamid [c]

[a] *PhD. Candidate, Department of Architecture, Faculty of Built Environment, Universiti Teknologi Malaysi,a Skudai, 81310, Malaysia*

[b] *Executive Director, Professor, Institute, Sultan Iskandar, Universiti Teknologi Malaysia, Skudai, 81307, Malaysia*

[c] *Department of Architecture, Faculty of Built Environment, Universiti Teknologi Malaysi,a Skudai, 81310, Malaysia*

Abstract

This paper presents confirmation of teaching methods employed in a sustainable design studio in Universiti Teknologi Malaysia. Quantitative method was employed where 25 Questionnaires were distributed to 5th year students and analysed using SPSS. The result found that the lecturers used various methods in teaching design studio but sustainable design issue was not of priority. Sustainability issue is mostly considered in elective subjects so sustainable ideas was not emphasized in design studio. Only students that offer the courses get acquainted with the issue of sustainability. Design studio can be Problem Based Learning as both have the same process and characteristics.

Keywords: Pedagogy, architectural education, problem based learning;

1. Introduction

Defining Education

The term Education has been defined by different scholars and philosophers. Hence, there is no unique definition of education as the concept has been exposed to different and often contradictory interpretations. Ducasse, (1958) noted that it comes from the Latin word "educere" meaning to 'lead out', or 'bring out'. But another school of thought denied that rather is "educare", which means to 'form' or 'train' (Schofield, 1972). Thus, with the coming of industrialism, and the increase in demand for knowledge and skills, 'education' became increasingly associated with 'schooling' and with the sort of training and instruction that went on in special instructions. The UNESCO International Standard Classification of Education (1995) defines education as comprising organized and sustained communication designed to bring about learning. The words communication, organized, sustained and learning are further explained, communication require a relationship between two or more people involving the transfer of information, 'organised' means planned in a sequence with established aims and curricular. 'Sustained' means the learning experience has to mean any change in behavior knowledge, understanding, skills or capabilities which the learner retains and which cannot be ascribed simply to physical growth or to the development of inherited behavior pattern (Thompson, 1981). Another definition by Fafunwa (1982) is that education is the aggregate of all the processes by which a child or young adult develops ability, attitudes and other forms of behavior which of positive value to the society in which he live. And Balogun, (2008) refers education to any act or experience that has a formative effect on the mind, character or physical ability of an individual. He further explained that education is a life-long process in what we continue to learn from experience throughout our lives.

2. Architectural Education

Architectural education is concerned with developing students in order for them to become well rounded, competent and imaginative designers of buildings and the spaces between them (Roberts, 2005). Architectural education in general and design studios in particular hold vast potential as a model for integrated learning. "It is a process, a way of thinking during which the many elements, possibilities, and constraints of architectural knowledge are integrated. Design studio sequence provides the connective tissue that brings together, progressively, the many elements of architectural education" (Siddiqi, 2002). Understanding the identity of this "subject" is the main part of the pedagogical approach if one hopes to reach the student while addressing relevant issues of architectural education (Yagiz & Dagli, 2001).

The "Reflective Practitioner" philosophy of Schon (1983) focused particularly on architectural and engineering education, was developed from Bauhaus principles and led initially to the introduction of "Problem-Based Learning". A variation on a combination of Schon's and Woods' (1985) themes was a "cognitive apprentice" model (also called "Problem-Based Learning"). This, in turn, was further adapted to architecture and design studio.

* Fa'izah Mohammed Bashir. Tel.: +6-014-611-9298
E-mail address:fmbashir3@live,utm,my

3. Pedagogy in Architecture

Academically, architecture is in fact itself pedagogy and each building have their own embedded hidden curriculum that can greatly influence and affect learning process. However, architectural education itself is severely criticized for not providing competent architects to the architectural profession. The built environment and the landscape can be a powerful tool of learning, in this regard the campus as a whole should be regarded as a place where learning occurs. There has been—and still is —a continuous debate among architects and architectural educators about the role of knowledge and research in architecture as a discipline and profession (Salama, 1996 & Sutton, 1984). Whether in developed or developing countries, many in architecture still think of researchers as people in white smocks and thick glasses searching for the mystery and the unknown. In response, scholars and educators have emphasized that research should be viewed as part of everyday actions and experiences.

Schon, (1985) analysed in detail on the issue of studio by examining the dialogue between instructors and design students, he has created a concept of "reflection in action" that is the ability of students to think about what they do and their effect on the time they make it. Schon and Wiggins, (1992) also stated that the design process involves a dialogue between designers and their design. This concept of "Reflection in action" has been used not only in architecture but also it has been popular in other professional fields such as engineering, medicine and the law. Cross (1982) also with the wise and inspired term "Designerly way of knowing" that a designer can be an expert when have been repeatedly made training in design until the designer know what good and not in the design

Salama, (2010) stated that Pedagogy in Architecture has both positive and negative tendencies the negative tendencies are that design concept and finishing is what is expected from the student. The finish product is what matter the process the student arrived at it is of no concern. The students are been rewarded based on the best looking project; this is because there is no clear cut goals and objectives from the beginning of the design approach and the instructors assume the master and students have to believe the master approach. While the positive tendencies are discussions are encourage and the transformation of student and permits learning about the process of changes in a dynamic environment.

Several education theorists including Kolb, (1984) voiced the opinion that experience should be an integral component of any teaching/learning process. Their work can be traced back to the famous dictum of Confucius around 450 BC "Tell me and I will forget. Show me and I may remember. Involve me and I will understand." Experiential learning refers to learning in which the learner is directly in touch with the realities being studied (Keeton &Tate, 1978). It is contrasted with learning in which the learner only reads about, hears about, talks about, writes about these realities, but never comes in contact with as part of the learning process. Mistakenly, some educators equate experiential learning only with "off campus" or "non-classroom" learning.

However, in architectural pedagogy a class in history or theory of architecture might incorporate periods of student practice on theory exercises and critical thinking problems rather than consisting entirely of lectures about theories of architecture and the work of famous architects (O'Reilly, 1999; and Salama & O'Reilly, 2002).

Learning through experience involves not merely observing the phenomenon being studied but also doing something with it, such as testing its dynamics to learn more about it, or applying a theory learned about it to achieve some desired results (Keeton &Tate, 1978).

Evaluation as a valuable research vehicle needs to be introduced both in lecture courses and design studios, establishing a knowledge base about the built environment that has the capability of endowing students with more control over their learning, knowledge acquisition, and design actions and decisions (Salama,1999).

Habraken (2003) argues that: We need to teach knowledge about everyday environment. How it is structured, what we can learn from historic and contemporary evidence, how different examples compare, how it behaves over time and responds to change of inhabitation or other circumstances. Teaching architecture without teaching how everyday environment works is like teaching medical students the art of healing without telling them how the human body functions. You would not trust a medical doctor who does not know the human body. Knowledge of everyday environment must legitimize our profession.

4. History of Problem Based Learning in Brief

PBL was first applied in business schools (Kwan, 2000), but it gained popularity when McMaster University, Canada started to implement the method as its major learning approach in its Medical faculty in the late 1960's (Schwartzz, Mennin, & Webb, 2001). The Medical faculty in the McMaster University has been using PBL for more than three decades. Having been recognized as an innovative educational approach and shown to have the potential to enhance the education process and its outcomes (Fadzidah, 2006). PBL has gradually been adopted by others. An important innovative aspect of PBL is the shift from teaching to learning. In PBL the learning process is initiated by a problem. Students are requested to discuss problem situations from professional practice among themselves raising questions that can be turned in to learning goals. The main task of the teacher is to facilitate the learning process instead of transfer of knowledge. Students are asked to analyze problems, before knowledge is activated. They are motivated to find answers to their own learning goals by means of independent study activities. The knowledge gained in this method is easier to retrieve that knowledge in practical cases (Banerjee & Graaff, 1996). There may or may not be a total ban on lecturing, the problems may vary in length or form, specific direction may be added to the case, and the facilitating role of the tutor may vary from just supervising the process to chairing each meeting and providing expertise and to facilitate group process by modeling higher order thinking and challenging the thinking of learners (Boud, 1985 &Woods, 1994).

5. Problem Based Learning

Problem based learning (PBL) has become increasingly popular in the tertiary education levels of many professional disciplines (Fadzidah, 2006). It is claimed to have maximum effectiveness in producing professional competencies among graduates, but its effectiveness in architectural education has never been thoroughly scrutinized. There is limited research and discussion on pedagogical approaches in architectural education, simply because it is considered as one of the "unimportant" areas that researchers "do not bother studying" (Teymur, 2001).

Since education is the least popular research topic in schools of architecture and strikingly research on architectural education has not been of concern to many academics (Salama, 2004), architectural education itself is severely criticized for not providing competent architects to the architectural profession (Fadzidah, 2006). This criticism is generated from the problems encountered within architectural education itself, where the lack of a formal theoretical framework leads to a disaggregated body of architectural knowledge (Nicol & Pilling, 2000). As such, the architectural education system is desperately in need of solutions to tackle such problems encountered (Moore, 2001 & Brown, 2002).

As PBL has been known to provide competent graduates in many other professional disciplines, there have been attempts to utilize the same pedagogical approach in architectural education as well. Here, PBL is seen as a potential solution to the problems encountered in architectural education. This is particularly the case with its pedagogical mechanism that is believed to provide learners with lifelong learning skills essential for future competency in professional practice (Gibbings, et al. 2008 & Polanco, et al. 2004). But Norman &Schmidt, (1992) argued that PBL appeared to sometimes reduce learning initially but over longer periods encouraged increased retention of knowledge and appeared to contribute to improved motivation and skills for self-directed learning.

PBL five common characteristics:

1. The starting point for learning is a problem (that is, a stimulus for which an individual lacks a ready response).
2. The problem is one that students are apt to face as future professionals.
3. The knowledge that students are expected to acquire during their professional training is organized around problems rather than the disciplines.
4. Students, individually and collectively, assume a major responsibility for their own instruction and learning.
5. Most of the learning occurs within the context of small groups rather than lectures (Bridges,1992).

6. PBL in Tertiary Education and Practice in Architectural Education

Problem based learning (PBL) is becoming an increasingly popular term in tertiary education (Kwan, 2000) as more and more educational disciplines implement the teaching and learning approach associated with the terminology. Previously believed to be monopolized by medical schools, PBL applies widely to learning in most professional schools and disciplines. In fact, some argue that it is the most significant innovation since the move of professional training into educational institutions (Fadzidah, 2006). PBL in architectural courses is usually confined to the studio and does not affect or interact with the teaching of other subjects in the curriculum (Maitland, 1997). Critical thinking, self-reflection, interdisciplinary and self-directed learning, and ill-structured problems are central to both PBL and design studio. Korydon suggests that learning outcomes, positive student attitudes, and student motivation increase in the problem-based environment when courses/curricula begin with a comprehensive tutorial session which contextualizes the PBL environment. It is in the opinion of the author that studio instructors must develop more numerous and more formalized group learning activities. The project-based environment—whether termed "PBL" or "design studio"—is being sought after for its core values: fostering critical thinking, cultivating collaborative skills, and inciting life-long learning Korydon (2005). Despite recent critiques of the long-standing traditions of the architectural design studio, it is difficult to imagine an alternative system of learning. The project-based environment is all too synonymous with the profession and practice of architecture Aaron, (2002). The design projects faced in architectural studios—whether in firms or in schools—are complex "problems" that require creativity, speculation, and self-criticism. Problem-based learning is the design process; "we cannot design without inherently thinking and working in a problem-solving mode" (Wayne, 2003).

7. Method

The method used for this study was quantitative and the data was analysed using SPSS, 25 Questionnaires were distributed to 5th year students. This study was done to reconfirm the studio pedagogy used by Architectural educators to teach sustainable design components in Universiti Teknologi Malaysia. The pedagogies used in this study were gotten from the interview conducted to the educators and the result has been published in Energy and Environmental Engineering Journal.

The study used fifth year students because they were in their final year and they have gone through all the studios required before graduating. 23 questionnaires were retrieved and were analyzed using SPSS and the reliability test for the questionnaire was also carried out as shown in Table 1 below.

8. Result and Discussion

The results of the questionnaires distributed to the 5th year students were as follows: In section A of the questionnaire, the sex shows that males were 12 and females were 11. 12 of the respondents were aged between 21-24 with highest % of 52.2%, while 10 were between 25-28years with 43.5% and only one was above 29 years. All of the respondents were full time students, 8 of them were from rural and 15 from urban. The house type of the respondents are: 12 from terrace, 3 from village, 3 from bungalow, 3 from duplex, 1 from low rise another 1 from multilevel. Only one of the respondents was not IT literate but the rest of 22 were IT literate. The respondents use different software for their design such as: CADD, sketch up, Photoshop, Revit, Artlantis, Vue, and Lumion.

To elicit consistent and reliable response for all the sections on Likert's scale, the Cronbach's Alpha- a tool for measuring the reliability or internal consistency of a psychometric test score was determined through SPSS. These Sections are B, C and E. The Alpha coefficient ranges in value from 0 to 1 in order to describe the reliability of the scale (Reynaldo and Santos, 1999) on the rating scale of 1= never to 5= very often in section B, 1= poor to 5= excellent in Section C and 1= strongly disagree to 5= strongly agree in Section E. The nearer to 1, that is the higher the score, the more reliable the measuring scale and the internal consistency. The generally accepted score is 0.7 (Cronbach, 1951), however, a lower threshold could sometimes be used in research if it falls between 0.6 and 0.7 (Cronbach, 1951; and Cronbach & Shavelson, 2004).

Table 1. Reliability test of the Questionnaire

SECTION	NO. OF ITEMS	CRONBACH ALPHA	REMARK
A	7	Demographic profile	-
B	8	0.768	Consistent
C	8	0.778	Consistent
D	10	Information sources	-
E	10	0.240	Not Consistent

Source: Researcher's field work, 2012

From the Cronbach alpha it shows that section B & C are reliable because there is consistency in the mean of variables tested. But the Cronbach alpha for the section E shows that is not reliable because is less than 0.6, so the questions on the section should be deleted or improved upon. The cause of the problem was because the curriculum does not deal with sustainable design issue effectively. The section can be repeated when the new curriculum is being implemented to confirm the effectiveness. Reliability test for the other sections were not run because there was no frequency needed.

Section D of the questionnaire was for the students to list other sources of components of sustainable design in which they listed the following: Internet, TV, Library, Books, Case study, Site Visits, Architectural Magazines, Catalogues, GBI, UAC, Nippon, GDB, Architect Firm, Lecturers, Movies, Existing Architectural works, Forum and Articles.

Table 2. Section B showing measurement of the pedagogy used by lecturers

Pedagogy used in teaching	Mean	Std. Deviation	Ranking
Interactive medium	2.5217	.79026	4th
Lectures	2.3478	.98205	5th
Scale models	3.3043	1.06322	1st
Case studies	2.2174	.85048	6th
Discussion during design process	2.0870	.66831	7th
Crit (table, open ,formal & by appointment)	2.0435	.82453	8th
Fieldtrip	2.8696	1.05763	3rd
Site visits	2.9565	1.10693	2nd

Source: Researcher's field work, 2012

Table 3. Section C Measuring how effective the formats used by lecturers in teaching

Formats used in teaching	Mean	Std. Deviation	Ranking
Interactive medium	2.5217	.73048	3rd

Lectures	2.5652	.72777	2nd
Scale models	2.8261	1.07247	1st
Case studies	2.2174	1.04257	5th
Discussion during design process	2.1739	.93673	6th
Crit(Table, open, formal & by appointment)	2.1739	.93673	6th
Fieldtrip	2.3913	1.23359	4th
Site visits	2.5217	1.23838	3rd

Source: Researcher's field work, 2012

Table 4. Section E measuring the understanding of sustainable design components

Sustainable design components	Mean	Std. Deviation
Have been taught about sustainable design	2.3043	.55880
Building using more artificial light is considered sustainable	3.7391	.91539
Rain water harvest is an active component of sustainable design	2.4783	.94722
Different wall & roof sprays can help energy efficient building	2.3478	.77511
Maximize shape of design to reduce harsh element of climate	2.5652	.78775
Building orientation to face north or south	2.1304	.75705
University encourages sustainable design when choosing project or thesis topic	2.4348	.66237
Fully involved in sustainable design	2.6957	.70290
Department has specific activity related to sustainable design	2.9565	1.10693
Establishment of interdisciplinary and multidisciplinary structures by the university	2.6087	.65638

Source: Researcher's field work, 2012

9. Conclusion

- In summary it was found that the lecturers use Scale models, site visits, field trip, interactive medium, lectures, case studies, discussion and crit as their studio pedagogy.
- Section C shows pedagogy used in ranking order highest to lowest Scale models, lectures, interactive medium, site visits, fieldtrip, case studies, crit and discussion.
- Section D shows the sources of sustainable design components as: Internet, TV, Library, Books, Case study, Site Visits, Architectural Magazines, Catalogues, GBI, UAC, Nippon, GDB, Architect Firm, Lecturers, Movies, Existing Architectural works, Forum and Articles.
- Section E reveals that students finds it difficult to comprehend with sustainable design question asked because the analysis of this section has a Cronbach's alpha of (0.240) due to sustainable design courses are taken as elective not core courses.

This study suggests Design studio itself can be classified as PBL, for the reason that design studio has the same characteristics of PBL as pointed out by Bridges, (1992). Other researchers also probably classified design studio as PBL seeing that both requires critical thinking, self-reflection, interdisciplinary, self-directed learning and ill-structured problems (Schon, woods,1985, Aaron, 2002, Wayne, 2003, and Korydon, 2005).

The paper concludes that architectural educators in Universiti Teknologi Malaysia do not use problem based learning as a major learning approach as done by other schools like Technical University Delft at Netherlands and University of Newcastle, Australia. But it is been used in such as a quick approach in form of experiment, Such as the day lighting experiment which is done by the students to solve day lighting problems. This experiment will help them throughout their life as architects to solve problems in day lighting cases. The study confirmed that the lecturers used various methods in teaching sustainable design. However, due to the curriculum deals with sustainable design courses as elective not core courses. So students find it difficult to apply sustainable design ideas into their studio design, since is not all students that offer the courses.

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References

Anderson, L. W. & Krathwohl, D. R. (2001). A taxonomy for learning, teaching and assessing: A revision of Bloom's Taxonomy of educational objectives: Complete edition, New York: Longman.

Aaron, K., Katherine, S., Dutton, A. T., & Deanna, S. (2002). The Redesign of Studio Culture. *A Report of the AIAS Studio Culture Task Force.* Washington, DC: AIAS, December, 2002.

Balogun, O. A. (2008). The Idea of an 'Educated Person' in Contemporary African Thought. *The journal of Pan African Studies*, 2(3), 117-128.

Banerjee, H. K & De Graaff, E. (1996). Problem-based learning in architecture: Problems of integration of technical disciplines. *European Journal of Engineering Education,* 21(2), 185-195.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956).Taxonomy of educational objectives: the classification of educational goals; Handbook I: Cognitive Domain New York, Longmans, Green, 1956.

Boud, D. (1985). Problem-based learning in perspective. In D. Boud (Ed.), *Problem-Based Learning in Education for the Professions* (pp. 13-18). Sydney: Higher Education Research Society of Australasia.

Bridges, E. M. (1992). *Problem based learning for administrators*. Eugene: ERIC Clearinghouse on Educational Management.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika. 16, 297-334.

Cronbach, L.J., Shavelson, R.J. (2004). My Current Thoughts on Coefficient Alpha and Successor Procedures Educational and Psychological Measurement, 64 (3), 391-418.

Cross, N. (1982). Designerly Ways of Knowing. *Design Studies* vol. 3(4), 221-227.

Ducasse, C. J. (1958). What Can Philosophy Contribute to Educational Theory? In: J. Park (Ed) *Selected Reading in the Philosophy of Education,* (London, Macmillan), (pp. 1-15).

Fafunwa, A. B. (1982). African Education in Perspective, in: A. B. Fafunwa, J.U. Aisiku (Eds) *Education in Africa: A comparative Survey* (London, George Allen and Unwin ltd.), (pp. 14-22).

Freire, P. (2006). Pedagogy of the oppressed, (M. B. Ramos, Trans). New York, NY: Continuum. (Original work published 1970--Freire, P. (1970). Pedagogy of the oppressed. New York, NY: Continuum Publishing Co).

Gibbings, P., Lidstone, J., & Bruce, C. (2008). Using Students Experience of Problem-based Learning in Virtual Space to Drive Engineering Educational Pedagogy. *In: 19th Annual Conference for the Australasian Association for Engineering Education: Industry and Beyond*, Yeppoon, Queensland.

Giroux, H. (1997). Pedagogy and the politics of hope: Theory, culture, and schooling. New York, NY: Westview/Harper Collins.

Habraken, J. (2003) Questions that will not go away: Some Remarks on Long Term Trends in Architecture and their Impact on Architectural Education. Keynote Speech: *Proceedings of the Annual Conference of the European Association of Architectural Education-EAAE*. Hania. Crete, Greece. (pp. 31-42).

Keeton, M. T. & Tate, P.J. (Eds). (1978). Learning by experience: What, why, how. New directions for experiential learning, No. 1. San Francisco, CA: Jossey-Bass, Inc.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. New Jersey: Prentice-Hall

Korydon, H. S. (2005). Problem-Based Learning in Architecture and Medicine: Comparing Pedagogical Models in Beginning Professional Education in Proceedings: *21st National Conference on the Beginning Design Student,* San Antonio.

Norman, G. R., & Schmidt, H. G. (1992). The psychological basis of problem-based learning: A review of the evidence. *Academic Medicine, 67*(9), 557-565.

O'Reilly, William (Ed) (1999) Architectural Knowledge and Cultural Diversity. Lausanne, Switzerland: Comportments.

Polanco, R., Calderon, P., & Delgado, F. (2004). Effects of a problem-based learning program on engineering students' academic achievements in a Mexican university. *Innovations in Education and Teaching International 41(2),145-155.*

Reynaldo, A. and Santos, J. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension,* 37(2), 1-4.

Roberts, A. (2006). Cognitive styles and student progression in architectural design education. *Design Studies,* vol. 27 (pp.167-181) doi:10.1016/j.destud.2005.07.001

Salama, A. M. (1996) Environmental Evaluation: A New Voice for Integrating Research into Architectural Pedagogy. *Journal of Architectural Research*. Cairo: Al Azhar University. November. (pp. 7-23).

Salama, A. M. (2010). A Process Oriented Design Pedagogy: KFUPM Sophomore Studio, *CEBE Transactions,* 2 (2): 16-31 (16) ISSN: 1745-0322.

Salama, A. M. O'Reilly, W. & Noschis, K. (eds.) (2002) *Architectural Education Today: Cross Cultural Perspectives*. Lausanne, Switzerland: Comportments.

Salama, Ashraf (1999) Incorporating Knowledge about Cultural Diversity into Architectural Pedagogy. In W. O'Reilly (ed) *Architectural Knowledge and Cultural Diversity*. Lausanne, Switzerland: Comportments. (pp. 135-144).

Salama, A. M. (2009). *Transformative pedagogy in architecture and urbanism*. Solingen, Germany: Umbau Verlag.

Salama, A. M. and Osborne L. (2009). Unveiling the experiential dimension of fieldwork. *Proceedings of the 6th International Conference of Architectural Humanities Research Association*, Edinburgh, University of Edinburgh.

Siddiqi, A. A. (2002). Architectural design studio projects and the charades of curriculum. *The 6th Saudi Engineering Conference*, KFUPM, Dhahran, December 2002.

Scholfield, H. (1972). *The Philosophy of Education* (London, George hallen and Unwin).
Schon, D. (1985). *The Design Studio. An Exploration of its Traditions and Potential*. London, RIBA Publications Limited.
Schon, D. A. and Wiggins, G. (1992). Kinds of Seeing and Their Functions in Designing. *Design Studies*, 13(2), 132-156.
Schon, D. A. [1983] The "Reflective Practitioner" University of Wisconsin (Milwaukee, US.
Sutton, S. (1984). Should Behavioural Studies Be Integrated Into the Design Studio. *Architectural Record*. July. (pp. 43-48).
Thompson, A.R. (1981). *Education and development in Africa*, (London, Macmillan Press Ltd.).
Wayne A. N. (2003). "Problem Solving through Design," *New Directions for Teaching and Learning,* 3(95), 39-44.
Woods, D. (1994). How to gain most from problem based learning. Hamilton, Ontario, McMaster University.
Woods, D. (1985). Problem-based Learning and Problem-solving, (Boud D. editor), *Problem-Based Learning in Education for the Professions,* Higher Education Research and Development Society of Australasia, Sydney. (pp. 19-42).
Yagiz, S. and Dagli, U. (2001). A Dynamic Approach to Studio Teaching in Beginning Design Education. *Architectural Education Exchange 2001, Architectural Educators: Responding to Change*. 11th -12th September 2001Cardiff University.

From Teaching to Facilitation; Experiences with Faculty Development Training

Erik de Graaff *

Aalborg University, Aalborg 9000, Denmark

Abstract

A shift from teaching to learning is characteristic of the introduction of Problem Based Learning (PBL) in an existing school. As a consequence the teaching staff has to be trained in skills like facilitating group work and writing cases. Most importantly a change in thinking about teaching and learning will have to be realized. In the implementation of PBL it makes a difference how the core features of the problem and the role of the facilitator have been defined. This paper will present components of a PBL faculty-development training programme and discuss the relevance with respect to the learning objectives for the teachers.

Keywords: *Faculty development, PBL workshop, Change to PBL*

1. Introduction

Problem Based Learning (PBL) is often said to involve a change of paradigm, or more specifically a shift from teaching to learning (De Graaff and Kolmos 2007). As a consequence, faculty development programmes aiming to train teachers in new skills are an integral part of the implementation of PBL. Teachers need to learn skills, like how to design a learning environment, how to write a case and how to facilitate a group process, but more importantly they need to re-define their professional identity in what is called a process of culture change. In this paper the outline for PBL faculty development training will be analysed based on extensive experience in running such programmes.

2. Different PBL Models

By the end of the sixties of the last century PBL emerged as the principal educational method at the new medical curriculum of McMasters University in Canada. PBL aims to involve students actively in the learning process, challenging them to work on problems from practice. Inspiration for the development of PBL principles came from pedagogues and psychologists like Jerôme Brunner, Maria Montessori, John Dewey, William Kilpatrick (Heitmann, 1996). In second half of the twentieth century the movement was carried on by American educators like Carl Rogers (1961), David Kolb (1984) David Boud (1986) and Donald Schön (1988). Theoretically their work fits nicely in the constructivist understanding of cognition from Piaget and Vygotski. The work of David Kolb on experiental learning is also often mentioned in this context. In practice PBL takes many shapes, resulting in a plethora of PBL models, ranging from PBL lectures, where the teacher builds his presentation around a case from practice to self-organized group work outside formal education. Several authors made attempts to classify different types of PBL (Barrows, 1986, Savin Baden, 2000, Prince and Felder, 2006; De Graaff & Kolmos, 2007).

The most important differentiation is the one between problem-based and project-organised learning. Both approaches originate for a large part from the same pedagogical background. Except, maybe, concerning the Marxist political orientation that influenced the development of Project Organised Learning in Europe, in particular in Germany and Denmark (Illeris, 2007). The section below focuses on the main differences between the ‘project’ PBL and the ‘problem’ version.

A project provides students with a challenging task that usually requires more than one single person to complete (Algreen-Ussing, 1990). Working out a solution among themselves in a small group is highly motivating for the students, as recognized by Kilpatrick In working on the project the students apply knowledge they acquired before and they learn new knowledge when they need it (Kilpatrick et al, 1921). The objective of a project is to solve a specific problem. As a consequence, it is by definition limited in time: the project ends when the problem is solved. Going from one project to the next the students gain experience in collaborating in a team in solving authentic problems from professional practice (Heitmann, 1996). Working on problems from practice has been a part of many university curricula for many years. For instance, Barry Maitland, the dean who introduced PBL in architecture at Newcastle University in Australia observes that ‘Architecture courses around the world almost universally retained one problem based learning feature derived from the origins of architecture education in tutelage and apprenticeship to a practitioner’ (Boud and Felitti, 1991). Interestingly this same architecture studio learning stood model for the development of the concept of the ‘reflective practitioner’ by Donald Schön (1988).

An alternative to having a group actually solving a problem is to trigger a learning process through using the problem as input for a group discussion. In such a case the ‘problem’ could be a description of a natural phenomenon, challenging the group to

* Corresponding Author Erik de Graaff
e-mail address: degraaff@plan.aau.dk

come up with a satisfactory explanation or a situation from professional practice as starting point for the discussion on the ensuing learning process. The choice of the type of problem depends very much on the profession the curriculum is training for. Working in a project is a natural preparation for a professional career in engineering. For other professions the link to a project is less obvious. In medicine, law or business administration it makes more sense to start with a case, or some observations in the context of practice. The way to present such cases to the students is in the form of a written description, sometimes supplemented with graphics. Unlike with a project assignment relevance is the most important criterion for the quality of a case rather than authenticity. A good case description reflects professional practice at a day-to-day level, i.e. a problem should not be a very rare combination of symptoms, or a situation so complex that even the most experienced practitioner will have difficulty overseeing everything (see Norman. 1988, for a comprehensive analyses of the concepts problem based learning and problem-solving).

The next aspect that differentiates between different versions of PBL is the location of the learning. PBL group work requires rooms to accommodate small groups rather than large classes or lecture halls. Work on an authentic technical project is done preferably in a workplace. Creating the right space for learning often is a big logistic challenge in setting up a PBL curriculum.

Alternative teacher roles are connected to different types of PBL. In the Maastricht PBL model the role of the tutor is defined strictly as a process facilitator. The tutor is a teacher that does not teach and consequently does not have to be a content expert. Students can consult content experts on request. In order to help students in running their own group process the groups are facilitated by a process facilitator (named 'tutor' in Maastricht) who helps them to work according to the principles of the 7-step procedure of problem solving (Schmidt and Moust, 2000). By contrast the project facilitator in the Aalborg model has to be a content expert, guiding students to make the right choices. In some schools this is taken one step further with the teacher assuming the role of project leader. However, when the teacher takes on much of the responsibilities of running the project, the motivation of the students is bound to decrease.

Also the task of the teacher with respect to assessment of learning outcomes varies across different types of PBL. Evidently, the Maastricht non-content expert facilitator cannot judge student-performance in anything but process skills. In order to resolve the problem that students tend to focus their attention on content they expect to be crucial in the examinations – thus limiting their freedom in self-directed learning - Maastricht did develop a progress test, an assessment method that is independent of the study programme (Verwijnen et al, 1982). In most other curricula teachers retain the responsibility to evaluate the learning outcomes of their own courses. For projects this tends to take the form of a project exam. In Denmark for some years the project exam has been banned by a government, which ruled that all exams at University must be based on an individual performance (after recent elections this ban has been lifted). Even so the project exam remains a complicated assessment instrument with serious issues regarding the measurement reliability.

3. Faculty Development Programmes and an outline for PBL training

Traditionally there is no need for a pedagogic qualification in order to teach in higher education. For a long time professional expertise and research performance were deemed sufficient to qualify as a professor. In the second half of the last century many universities in the North West of Europa, recognising the need for pedagogic training, established staff development centres. Usually, these centres offered pedagogic training on a voluntary basis, limiting the impact (De Graaff and Sjoer, 2006). Since the beginning of the present century the attention for the role of staff development in ensuring the quality of teaching and learning increased markedly (De Rijdt, 2011). For instance, in the Netherlands all universities agreed to enhance training programmes for newly appointed teachers and to recognize results from each other's staff development programme (De Graaff et al, 2006).

Staff development is an essential aspect of educational innovation, in particular when a new pedagogic method is introduced, like PBL. Self-directed collaboration in small groups is a core characteristic of PBL. Students are expected to run their own group-meetings and to plan their own study activities. Implementing PBL entails a process of organisational change. The allocation of responsibility for tasks like educational design and assessment of learning outcomes must be re-considered and the teaching staff should acquire new competencies. For the people involved, adjusting to the process of educational innovation implies a process of cultural change. For instance, the members of teaching staff need to learn share responsibilities across traditional discipline boundaries and to collaborate in interdisciplinary educational design teams, very much like the student study groups.

Over the past 25 years the author has been conducting hundreds of workshops on PBL facilitation skills in many schools around the world. Often these workshops were part of an educational change strategy, ranging from an orientation stage to concrete preparations for actual implementation. The objective of such a workshop from the perspective of the persons driving the change process is consistent with a rational strategy as well as with a re-educative strategy (Chin and Benne, 1985). In the first place, a workshop is expected to inform staff members about the advantages of the PBL model. Therefore, general presentations on PBL principles and examples of best practices are often included in the training programme. Next, in order to understand what the introduction of PBL involves for the role of the teachers, there should be workshop elements allowing participants to practice PBL skills, like facilitation and case construction. The facilitator needs to practice techniques allowing them to make interventions without disturbing the on-gong process of self-directed learning, like: summarizing, mirroring behaviour; asking open-ended questions and get feedback on his/her own performance. In some cases the workshop specifically aims to contribute to a change in attitude towards teaching and learning. An example of an exercise that aims for such objectives is the dance of edicational innovation (De Graaff and Mierson, 2005).

Learning objectives and the most common elements of the training programme are represented in the overview in table 1. Please bear in mind that the time table only gives only a rough estimate of the time needed. The programme can easily be tailored to suit particular local needs, like repeating some of the practice elements in order to give more people the opportunity to participate.

Table 1. Components of PBL faculty development training

Intended Learning Outcomes for PBL training programme: After following the course the participant will be able to:

- recognize the active components of PBL
- apply the basic principles of PBL tutoring (facilitation the learning process)
- be able to reflect on his/her own tutorial skills
- understand the implications of implementing PBL
- motivate when to apply which PBL variety

Components of a 2-4 days faculty development programme:		
Topic	Comments	Time
Plenary presentations		
PBL Models and pedagogic principles	Basic background information	60 min
Best practices PBL	Inspirational examples	60 min
Facilitation versus teaching	Teacher tasks in a PBL curriculum	45 min
Designing an environment for active learning	Course development	45 min
Management of change	How to organise the change process	60 min
Assessment and evaluation	A key to successful implementation	60 min
Exercises		
Introduction participants	Breaking the ice	30 min
Learning and teaching experiences	Your own experience is your inner criterion	60 min
Designing an environment for active learning	Course development	120 min
Project work	Experiencing working in a project	180 min
Facilitation skills	Non-directive teaching	180 min
Project presentations and feedback	Assessing and being assessed	120 min
Strengths and weakness of PBL	Exchange of opinions and experience	90 min
Comments and Questions	Wrapping up	60 min

4. Evaluation

At the end of each training programme there is some time set aside for reflection on the programme with comments and question. In some cases there is also a more formal evaluation organised by the host institute. Usually these evaluations are mostly positive, although there are always some participants with comments. The point is such evaluations presume a quantitative analysis, calculating an average of ratings. However, how you experience a workshop depends at least partly on yourself. Therefore, it makes no sense to add up the ratings of 20 people who enjoyed the workshop with the score of one person who had a bad day.

For a thorough evaluation you would like to assess different aspects within the personal context of the persons involved. As such an evaluation would take up too much time we will have to look for alternatives. I have often used the following exercise, labelled 'one-word impressions' in order to sum up the comments is asking all participants to reflect on the course: '*Please take a few moments to look back at the past day(s). Try and find one word to sum up your experience. You do not need to elaborate or explain this one word'*. Below a selection of words collected during the past years is presented:

'fantastic'; 'inspirational'; 'new ideas'; 'challenging'; 'insight'; 'so easy'; 'unexpected', 'surprising'; 'possibilities'; 'potential'; 'flabbergasted'; 'shocked'; 'disoriented'; 'difficult to do'; 'disappointed'; 'positive'; 'experience'; 'facilitation'; 'stepping back'; 'observation'; 'safety'; 'mirror'; 'problems'

The list is not exhaustive, but it gives a good impression of the kind of one-word statements that are made (a few actually need more than one word). Of course people like to explain their word choice afterwards. What stands out in these explanations is that people really only start to get a grasp of the concept of facilitation after being confronted with direct feedback in a groups exercise. For most teachers at the start it is inconceivable to do anything but to take the lead in the process. Even in role-play exercises where they do not have the necessary expertise, many teachers naturally assume a position of authority. The surprise comes when they get feedback from colleagues who tell them how they experience such a facilitator intervention.

Surprisingly, some people alter the connotation of their one-word evaluation with their explanation. For instance, someone explicated that the apparently negative word *'disappointed'* came to his mind because it was all so simple now that he saw how it came together. In general I would say that the workshops have been successful for as far as it has been possible to generate this general feeling of understanding and in particular the sense of a growing ability to make it work in practice.

5. Conclusion and discussion

Faculty development constitutes an integral part of educational innovation. At the very minimum workshops will serve to explain teaching staff what the innovation is about in terms of teaching behaviour. A more ambitious objective is to initiate a process of cultural change. It is difficult to answer conclusively the question to what extent such courses contribute to a change in educational culture. Of course the effectiveness will differ from one situation to the next. The overview generated by the 'one-word impressions' is highly subjective and by no means representative of all participants in a statistical sense. Still it generates a sense of the main trends in experiences at the end of the workshop. In particular because participants respond to other contributions and with the explanations afterwards added to complete the picture the impressionist understanding of the summing up is quite strong.

The key areas' in the faculty development training-programme appear to be the exercises that allow participants to practice PBL skills. The learning experiences quoted above show that course participants are more impressed by direct feedback on their own actions than by theoretical explanations of PBL concepts. Problem Based Learning requires a different type of interaction between teachers and students. Different in what way, depends on the type of PBL. In particular the role of a facilitator is difficult to learn for a teacher with extensive experience in a traditional curriculum. The facilitator is supposed to aim interventions primarily at the on-going process of self-directed learning. In project organised learning the facilitator needs to be a content expert, yet still the interventions should not obstruct the self-directed process. Acquiring the skills of a facilitator involves a re-definition of the role of a teacher. The evaluations of a large series of training programmes confirm that the most important learning experiences reflect a rising awareness of the effects of your interventions as a facilitator. The fact that in role-play exercises colleagues provide the feedback makes it even more effective. While essential for the implementation of PBL I would maintain that learning what it takes to become an effective facilitator adds value to any teacher in any type of curriculum.

Whether a strategy to implement PBL will be successful depends on many different factors. Yet, it is beyond a doubt that courses to train faculty in PBL skills are an essential part of the implementation of PBL and the most crucial effect of such a course is to raise the awareness of the teachers enabling them to change their perception of their own role in relation to the student's learning process.

References

Algreen-Ussing, H. and Fruensgaard, N.O., (1990) *Metode I Projektarbejde*, Aalborg University Press.

Berthelsen, J., Illeris, K., Poulsen, S.C., (1977) *Projektarbejde*, Borgen, Kbh.

Barrows, H.S. (1986) A taxonomy of problem-based learning methods. *Medical Education*, 20, 481-486.

Boud, D. (ed.) (1985) *Problem-based-learning in education for the professions.* Sydney: Higher Education Research and Development Society of Australia.

Boud, D. & Feletti, G. (1991) *The Challenge of Problem-based Learning*. London: Kogan Page. 333p.

Chin, R. & Benne, K.D. (1985). General strategies for effecting changes in human systems. In W.G. Bennis, K.D. Benne & R. Chin (eds.) *The planning of change* (fourth edition). Holt, Rinehart & Winston, New York.

De Graaff, E and Kolmos, A (2003): Characteristics of problem based learning, *International Journal of Engineering Education*, vol. 17, no. 5, pp.

De Graaff, E. & Sheella Mierson (2005) The dance of educational Innovation. *Teaching in Higher Education*. Vol. 10. No 1. pp. 117-121.

De Graaff, E. and Kolmos, Anette (2007*). Management of change implementation of problem-based and project-based learning in engineering*. Netherlands: Sense Publishers. 221 p.

De Graaff, E., Andernach, J. A. , & Klaassen, R. G. (2006). Learning tot teach, teaching to learn the impact of a didactic qualification programme on university teachers careers. In Jones, M., Krieger, A., Reichl, F., & Steiner, A. (eds.), *Proceedings of the 10th IACEE World Conference on Continuing Engineering Education* (pp. 1-6). Vienna: Vienna University.

De Graaff, E., & Sjoer, E (2006). Positioning Educational Consultancy and Research in Engineering Education. In: *Proceedings of the 34th Annual SEFI Conference* (pp. 98-101). Uppsala: Uppsala University.

De Rijdt C.C.E. (2011) *Staff Development in Higher Education*. Thesis defended at the University of Maastricht, Maastricht: Universitaire Pers.187 p.

Gijselaer, W. H. (1996). Connecting problem-based practices with educational theory. In Wilkerson, L. and Gijselaers, W. H. (Eds.). *Bringing problem-based learning to higher education: Theory and practice*. San Francisco: Jossey-Bass.

Heitmann, Günter (1996): Project-oriented Study and Project-organized Curricula: A Brief Review of Intentions and Solutions, *European Journal of Engineering Education*, 21:2, 121-131.

Illeris, K. (2007). *How we learn – Learning and non-learning in school and beyond*. New York: Routledge.

Kolmos, A (1996): Reflections on Project Work and Problem-based Learning, *European Journal of Engineering Education*, Vol. 21, no. 2.

Kolmos, A., De Graaff, E., Du, X. (2009). Diversity of PBL: PBL learning principles and models. In Du X.; De Graaff E. and Kolmos, A. *Research on PBL practice in engineering education* (pp. 9-21). Rotterdam: Sense Publishers.

Kilpatrick, W. H., Bagley, W. C., Bonser, F. G., Hosic, J. F., & Hatch, R. W. (1921). Dangers and difficulties of the project method and how to overcome them. *Teachers College Record*, 22, 283-321.

Neufeld, V.R. and Barrows H.S. (1974). The McMaster philosophy: an approach to medical education. *Journal of Medical Education*, 49: 1040-1050.

Norman, G.R. (1988) *Problem-solving skills, solving problems and problem-based learning*. Medical Education, 22, 279-286.

Prince, M.J. and R.M. Felder, "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases." *Journal of Engineering. Education*, 95(2), 123-138 (2006).

Rogers, C. (1961) *On becoming a person.* Boston: Houghton Mifflin

Savin-Baden, M. (2000), *Problem-based Learning in Higher Education: Untold Stories,* SRHE and Open University Press, Buckingham.

Savin-Baden, M. (2007). Challenging models and perspectives of problem-based learning. In Graaff, E. de and Kolmos, A. (Eds.). *Management of change: Implementation of problem-based and project-based learning in engineering* (pp. 9-30). Rotterdam: SENSE Publisher.

Schmidt, H.G. & Jos H. C. Moust (2000). Factors affecting small-group tutorial learing: A review of research. In Dorothy H. Evensen and Cindy E. Hmelo (Eds.). *Problem-based learning: A research perspective on learning interactions*. Mahwah, N. J.: Lawrence Erlbaum Publishers.

Schön, Donald A. (1988) *Educating the reflective practitioner*. San Francisco - London: Jossey-Bass Publishers.

Verwijnen, G.M., Imbos, T., Snellen, H., Stalenhoef, B., Pollemans. M., Van Luyk, S., Sprooten, M., Van Leeuwen, Y. and Van der Vleuten, C.P.M. (1982) The evaluation system at the medical school of Maastricht. *Assessment and Evaluation in Higher Education*, 7, 3, 225-244.

Wilkerson, L. and Gijselaers, W. H. (Eds.), (1996), *Bringing Problem-Based Learning to Higher Education: Theory and Practice,* Jossey-Bass Publishers, San Francisco.

Students Participation and Facilitation in PBL Tutorial Session

Alias Masek[a] *, Sulaiman Yamin[b], Ridzuan Aris [c]

[a,b]*Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia,*
86400 Batu Pahat, Johor, Malaysia
[c]*Department of Electrical Engineering, Merlimau Polytechnic, 77330 Merlimau, Melaka, Malaysia*

Abstract

Students' participation in the PBL group discussions has always been associated with the role of facilitator, who is responsible for the effectiveness of tutorial sessions. This paper examines the participation of first-year polytechnic students in PBL group discussions and proposes a method of facilitation. The PBL was implemented for ten weeks according to the fourteen-step PBL procedures. Students solved five problems in a two-week block period. Students' participation was observed and videotaped. Students also responded using a fixed reflective journal while attending all the tutorial sessions held in the 10-week period. At the beginning of the discussion session, students felt awkward to communicate with other members of the groups. They liked to chat with their partners, and the groups generally lacked discussion skills. A serious discussion session only lasted for less than 10 minutes; as a result, no clear decision was made at the end of the discussion session. Therefore, several suggestions were proposed to develop a facilitation technique: to create an environment conducive to discussions and carry out monitoring every 10 to 15 minutes.

Keywords: Problem-based learning, facilitation, participation, tutorial session, engagement with PBL, electrical engineering

1. Introduction

A facilitator's prescriptive tasks in a Problem Based Learning (PBL) environment require a long list of actions to be identified. Facilitators should apply their knowledge and skills of a subject matter expert or procedural expert in the tutorial class, especially in group discussion sessions (Wee, 2004). Among the important tasks, a facilitator is to guide students throughout the process of learning in order to fulfil the course learning outcomes. In addition, a facilitator has to deal with group dynamics, fostering a suitable climate for collaborative learning (Wee, 2004). In particular circumstances, a facilitator is responsible for resolving team conflicts through diplomatic and negotiation skills (Savin-Baden, 2003; Sabburg, Fahey and Brodie, 2006). One major responsibility of a facilitator is to ensure appropriate level of participation and the use of resources in order to increase group effectiveness (Justice and Jamieson, 2012).

Determination of students' levels of participation in a PBL group discussion has been very subjective. Previous studies agreed that measuring participation can be done as a group property but not as an individual count (Paletz and Schunn, 2011). Some studies have examined individual participation rates in relation to communication of influence or persuasion of members of a team (Burgoon and Hale, 1987). In fact, some researches propose a matrix for measuring an individual's participation (Paletz and Schunn, 2011): rubric, questionnaire, and informal self-assessment (Knight, 2011). It is argued that the level of participation can be observed from the pattern of interaction and contribution of members in a group, which are actions indicating an individual's behaviour (active-passive), oral ability (silent-talkative), group skills (excellent-poor), and confidence (high-low).

Previous authors pointed out that behaviour, oral ability, confidence level and group skills are associated with one another; the combined effects of these four factors influence an individual's participation in the group discussion (Remedios et al., 2008). A student's active or passive behaviour in participating in group discussion has been explained in the Model of Learning and Teaching Styles (Kolb, 1984). When a student actively participates in a discussion session, the student talks, moves, and reflects on the subject matter; when a student switches to passive mode, the student watches and listens. However, a student's actions of talking, moving, and reflecting within a group might end up in disaster without proper group skills. An appointed leader must function as an individual who coordinates a discussion orderly and effectively according to procedures. In order for everyone to attain success of learning, a group should comprise members with understanding of content matter and good communication skills; they should also demonstrate a high level of confidence in presenting views and opinions in the discussion session.

In this context, an ideal facilitator should have two sets of skills (Wee, 2004). Firstly, the facilitator must possess skills relating to PBL process and procedures, such as dealing with group dynamics and fostering suitable climate for collaborative learning. Secondly, the facilitator must be equipped with skills to stimulate students' meta-cognitive ability, such as probing, questioning, provoking, and any other methods that can encourage students to think creatively. In certain circumstances, the facilitator must be capable of resolving team conflicts through diplomatic and negotiation skills (Savin-Baden, 2003; Sabburg, Fahey and Brodie, 2006).

Using PBL as a platform, a facilitator is the most important person who can influence students' participation in a group discussion. Hung (2009) proposed a facilitation method based on students' capability: minimal, moderate, or aggressive guidance

* Corresponding Alias Masek. Tel.: +06-017-747-2042
E-mail address: aliasmasek@uthm.edu.my

is provided for students depending on maturity levels of students. However, it is difficult to prescriptively define a set of procedures for effective facilitation and stimulation of active participation to ensure effective learning. Existing models of facilitation such as the pyramid model of facilitation (Hunter et al., 2009) are sometimes difficult to be applied in practical group environment, especially in educational context. In addition, specific methods of facilitating PBL group discussion sessions are dependent on individual skills of a facilitator. Therefore, this paper investigates the pattern of students' participation and proposes a facilitation technique for effective learning in the PBL group discussion sessions. The findings reveal a pattern of participation and behaviour of the first-year students in the PBL group discussions.

2. Methodology

The data reported in this paper were a subset drawn from an experimental study among engineering students to compare the effects of PBL and Traditional Learning Approach in terms of knowledge acquisition, critical thinking ability and intrinsic motivation. While the comparative study provided a major finding from quantitative data, the combination of several qualitative data provided another significant finding. The qualitative data of the study consisted of an observation by the third author, video data, reflective journal, and field notes.

Participants comprised 27 first-year undergraduate students from the electrical engineering course in one of the polytechnics in Malaysia; 24 of them were male and the remaining 3 were female. These students had undergone ten weeks of PBL tutorial sessions in one of the compulsory modules, namely Electrical Technology. Data field notes were collected by a facilitator (the third author) during the PBL group discussion sessions according to descriptive and reflective methods (Emerson et al., 2011). In descriptive method, the observer records the natural setting, actions and conversation taking place in the tutorial session. In reflective method, the observer records ideas, thoughts and concerns based on observation or reflection of events taking place in the tutorial session.

At the end of the 10-week tutorial sessions, field notes of 20 sessions as well as 135 pages of fixed-reflective journals were analysed. Data from field notes and students' fixed-reflective journal were transcribed digitally into a matrix form. The data from videotapes were repeatedly watched and used to double check students' behaviour and participation during the discussion sessions.

2.1. Brief notes on PBL tutorial session

The instruction was based on the 14 steps of PBL procedures (Masek and Yamin, 2012). Briefly, during the first meeting, students were divided into groups according to previous test results such that higher-score and lower-score students were evenly distributed (heterogeneous group). A total of seven groups were formed: six groups each with four members and one group with three members. They were then asked to appoint a leader for each group and were briefed on the PBL procedures.

Students were given five PBL subject-focused problems (subject-centric) during the 10-week PBL tutorial sessions. One problem required a two-week block of time to complete one cycle of PBL procedures. In the two-week block, it was compulsory for students to attend two tutorial sessions. The first session was dedicated to problem delivery and group brainstorming, while the second session was devoted to group discussions (decision- making) and presentation.

Both sessions of group discussions were videotaped and recorded in field notes (by the third author). The video data were used to validate the data from the field notes jotted down by an observer regarding students' participation during the PBL group discussions. The writing of reflective journal was implemented for each student at the end of the second session (one complete cycle of PBL procedures). The purpose of the reflective journal was to capture students' participation in the PBL group discussions; the journal contained fixed questions such as "what is the most motivating thing in PBL session" and "what is the most frustrating thing in PBL session".

3. Findings and discussions

Several repeated patterns of interaction were identified in order to understand students' participation during the discussion sessions. These patterns were set up as a base for critical comments and discussions regarding students' participation during PBL group discussion sessions. These patterns include the students' behaviour (active-passive), oral ability (silent-talkative), group skills (excellent-poor), and confidence (high-low) as described in Table 1:

Table 1: Themes from data matrix of extracted field notes and fixed reflective questions

TYPE	DESCRIPTIONS
Behaviour *Active-passive*	• Some group members actively participated in the discussion activities. They moved, talked and reflected on one another's responses. • Some group members passively participated in the discussion activities. They moved less, did minimal talking and did not reflect at all (during the first and second PBL cases).

Oral *Silent-talkative*	•	Some group members were talkative persons. They talked about relevant and irrelevant topics of discussion.
	•	Some group members were quiet for at least 10 to 15 minutes during the discussion session.
Group skills *Excellent-poor*	•	Group skills were excellent for some groups. Procedural discussion was observed: chairman, secretary and contributors.
	•	Group skill was poor for some groups. No procedural discussion was observed.
Confidence *High-low*	•	Some group members have high levels of confidence in action, behaviour, communication, contributing ideas and proposing solutions.
	•	Some group members have low levels of confidence in action, behaviour, communication, contributing ideas and proposing solutions.

Table 1 indicates the pattern classifications of students' behaviour, oral ability, group skills, and confidence level during discussion times in the PBL group tutorial sessions. These classifications can produce several combinations as listed below:

Active and talkative group: A number of groups were active during the discussion sessions (on topic or off topic); the members of these groups were talkative persons. Students who were talkative persons were involved in the discussion sessions and got along well with other members. Particularly, the PBL problem was discussed rigorously from many possible aspects, and several possible solutions were also identified. These active participation and spontaneous responses were reflected in excellent presentations with good contents and proposals having minimal errors. Interestingly, there were some students who were identified as quiet persons, but they appeared to be contributors of ideas for these particular groups.

Passive and quiet groups: This category usually has two distinct types of groups exhibiting different characteristics. Firstly, a successful group with passive members; the group was led by quiet but brilliant or hardworking members. Secondly, a failure group; some members did not cooperate and some other members were quiet participators who seldom talked (Remedios et al., 2008). Two occurrences can be observed in the successful group (first case): first, some students kept silent and only talked when they were prompted by other members; second, some students kept silent and only listened to others for the first 10 to 15 minutes. In the first PBL group discussion, it could be observed in both types of groups that several students were shy and felt awkward to participate in discussions, especially when there were female members in the group.

High confidence and poor group skills: Several groups were observed to have high levels of confidence in conducting group discussions. However, members lacked group skills in order to have an effective discussion session. Members contributed ideas and the discussions appeared organised and procedural, but no one took down notes.

Low confidence but excellent group skills: Several groups were observed to have low levels of confidence but they had good ideas and skills in problem solving. A member of the group was actually brilliant and creative, but members were hesitant to start the discussion of the topic given. The group wasted quite some time at the beginning before some members kick-started the discussion session.

4. Discussions and recommendations

Literature suggests that skills of facilitators are one of the three main input variables that influence tutorial group process, which in turn determines cognitive and motivational outcomes (Arts, Gijselaers and Segers, 2002). It is believed that by improving group process, individual participation will also increase; the key is that facilitators must play their roles appropriately according to the nature of individual groups. In considering these constructs, one might argue that variables such as student characteristics will substantially affect the amount of self-study and the level of students' participation in learning. However, it must be noted that without a facilitator's guidance, it is doubtful that group discussion can be effective since individual participation is minimal or perhaps none at all.

Premised on these findings, four constructs were derived based on the dynamics and variety of group nature and action in the PBL group discussion sessions as well as existing literature. Basically, several possible combinations can be created based on the four constructs, but four major combinations are highlighted for discussion in this paper. Therefore, several recommendations for facilitation techniques are proposed especially for those practising the concept of floating facilitator, which is mainly based on group nature.

Generally, for the active and talkative groups, the identified quiet individuals can be put together with those who are more talkative to encourage communication and effective discussion sessions. The quiet individuals appear to be good critical thinkers because they are capable of debating ideas proposed by other members as well as facilitators. This does not always happen because the quiet individuals sometimes are not in the same groups as talkative members. However, in order to maintain the level of control, autonomy as well as the inclusion of social aspects of students' learning (Arts et al., 2002), facilitation techniques are proposed to deal with participants according to the identified group nature as defined above.

Active and talkative group: The top priority job is for the facilitator to frequently monitor discussion sessions and guide participants to move along the right path. Naturally, the purpose of facilitator intervention is to improve the way participants identify and solve problems (Schwarz, 2002); the actions of facilitators must serve to trigger students' meta-cognitive ability, such as probing, questioning, provoking, and any other methods that may stimulate students' thinking process (Wee, 2004).

However, it is suggested that the level of facilitator intervention be kept to the minimum to avoid disrupting the momentum of group discussions.

Passive and silent group: The facilitator should provide aggressive guidance to excite members so that the groups can take off with warm and lively discussions. In this context, aggressive guidance means to encourage collaborative learning among members within a group, inside and outside of the tutorial class (Arts et al., 2002). In the tutorial class, the facilitator promotes warm and lively discussions amongst group members by injecting a hot topic, a controversial issue, or a particular concern relevant to the problem in hand. Another role of the facilitator is to monitor participation of individual students in brainstorming sessions. Outside the tutorial class, the facilitator encourages students to have independent group discussions and self-study sessions; this will provide opportunity for group members to speak and contribute ideas.

High confidence and poor group skills: The group requires less help from the facilitator to start on discussions. The facilitator's role is limited to suggesting members of the group to be chairman, secretary, and contributors in the discussion session. The facilitator has to monitor the discussion at the beginning before leading the group to work independently. Justice and Jamieson (2012) highlighted the necessity of group members' function at appropriate levels of participation and the proper use of resources in order to have an effective group discussion. Minimal guidance from the facilitator is needed for this type of PBL group.

Low confidence but excellent group skills: The group members require some ideas from the facilitator to start on discussions. Everyone is hesitant to contribute ideas although they have been thinking so much about the topic given. The main issue is that students are less confident to speak up. According to Schwarz (2002), group effectiveness can be increased by creating a discussion environment that is substantively neutral. It is suggested that the facilitator acts as a fellow learner within the group to create an informal discussion environment. The discussion in this case should be continuous similar to normal conversations and chats with friends.

5. Conclusion

Generally, in PBL tutorial sessions, it is facilitators' responsibility to promote effective group discussions and to stimulate effectiveness of participants according to dynamic group nature. By increasing participation of individuals in the discussion session, one group might effectively operate under the facilitator's supervision. Several steps are essential for smooth group functioning, such as allowing the group to appoint a leader that rotates for every single project and letting students decide who the first leader is. Facilitators are also responsible for monitoring groups every 10 to 15 minutes; the aim is to create a friendly environment, impart group skills, and update discussion progress every 10 to 15 minutes. Facilitators must also emphasise clear findings to increase effectiveness of group discussions.

References

Arts, J.A.R., Gijselaers, W.H. & Segers, M.S.R. (2002). Cognitive effects of an Authentic computer-supported, problem based learning environment. *Instructional Science, 30*, pp. 465-495.

Burgoon, J. K., & Hale, J. L. (1987). Validation and measurement of the fundamental themes of relational communication. *Communication Monographs*, 54, 19–41.

Emerson, R.M., Fretz, R.I. & Shaw, L.L. (2011). *Writing ethnographic field notes, 2nd* edition. U.S: The University of Chicago.

Hung, W. (2009). The 9-step problem design process for problem based learning: application of the 3C3R model. *Educational Research Review, 4,* pp. 118-141.

Hunter, D., Thorpe, S., Brown, H. & Bailey, A. (2009). *The art of facilitation.* New York: Willey.

Justice, T. and Jamieson, D.W. (2012). *The Facilitator's field book.* Third edition. United States: HRD Press.

Knight, D.D. (2011). Assessing Class Participation: One useful strategy: Tips for encouraging students participation in classromm discussion. The Teaching Professor. United State: A Magna Publication. Pg 4.

KoIb, D.A., Experiential Learning:Experience as the Source ofLearning and Development, Prentice-Hall, Englewood Cliffs, N.J., 1984.

Masek, A. & Yamin, S. (2012). A Comparative study of the effect of Problem Based Learning and Traditional Learning Approaches on Students' Knowledge Acquisition. *International Journal of Engineering Education,* Vol. 28 (5), pp. 1161-1167.

Paletz, B.F.S. & Shunn, C.D. (2011). Assessing group-level participation in fluid teams: testing a new matric. *Behav. Research,* DOI: 10.3758/s13428-011-0070-3.

Remedious, L., Clarke, D., and Hawthorn, L. (2008). *The silent participation in small group collaborative learning contexts.* University of Melbourne: PhD. Thesis

Sabburg, J., Fahey, P. & Brodie, L. (2006). Physics concepts: Engineering PBL at USQ. *Proceeding of 17th National Congress.* Brisbane: RiverPhys. pp. 105.

Schwarz, R. (2002). *The Skilled Facilitator: A comprehensive resource for consultants, facilitators, managers, trainers, and coaches.* San Francisco: Jossey-Bass Publisher.

Savin-Baden, M. (2003). *Facilitating Problem Based Learning: Illuminating Perspectives.* Buckingham: Open University Press.

Wee K.N.L. (2004). *Jump Start Authentic Problem Based Learning*. Singapore: Prentice Hall Pearson Education South Asia Pte. Ltd.

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Project Oriented Design Based Learning – Staff Perspectives

Sivachandran Chandrasekaran [a], Alex Stojcevski [b], Guy Littlefair [c], Matthew Joordens [d]

[a]PhD Student in Engineering Education, Deakin University, Geelong 3216, Australia
[b]Professor & Head of Electrical and Electronics Engineering, Deakin University, Geelong 3216, Australia
[c]Head of School of Engineering, Deakin University, Geelong 3216, Australia
[d]Associate Head of Teaching and Learning, Deakin University, Geelong 3216, Australia

Abstract

The focus of this paper is to get staff perception on design based learning in their respective disciplines and how they could be aligned to the newly proposed model, in project oriented design based learning (PODBL). In academia, students and staff are supposed to work together in order to achieve a balanced learning and teaching process. By using different teaching and learning approaches, teachers are aware of escalating the student knowledge to fulfill current technology needs. This paper is part of a continuing process of a research project, which analyses better teaching and learning approaches in engineering. As part of this research, face-to-face interviews with staff members of the school of engineering in Deakin University who are teaching engineering design were conducted. The interview questions are based on qualitative analysis. The questions covered here are designed to determine the staff level of experience from teaching engineering using design based learning approach as an educational model. From the analysed results, this research encourages the school to practice a unique pedagogy that will accomplish the students learning outcomes.

Keywords: Design based learning (DBL), Project oriented design-based learning (PODBL), engineering education.

1. Introduction

In engineering education, students are active learners while teachers are perceived as facilitators. All universities have the capability to produce qualified professionals by motivating and developing the skill set of students to become experts in a chosen field. Many educators have practiced different teaching and learning approaches to teach the students about engineering design, design process, engineering and technology, discipline related engineering practice. Especially when it comes to solving a design problem, which students have to experience in their future industry jobs. Students need to learn to solve design problems, they need to use design process as a methodology to approach a problem and they have to understand the user requirements for an end product. It is a vital role of an engineer to satisfy the need of user in every domain of designing an end product. This research project is part of a larger research project, which was concerned with improving teaching methods, and therefore requires face-to-face interviews with the staff members who teach and perform research in engineering design.

2. Different learning approaches

Project based learning – In this approach, the central focus is on projects. Projects are focused on questions or problems that initiate the student learning. Learning through projects is time consuming approach that is interpreted in terms of an assignment or task performed by the students (Chandrasekaran, 2012a). The common element in project based learning and problem based learning is learning processes which is a central principle to enhance students motivation. Project based learning are perceived to be student centred approaches to learning. It is predominantly task oriented and the tutor often sets project to the students. In project based learning, students are required to produce an outcome as a report supervised by the supervisors. Here students need to produce a solution to solve the problem where the result should be in the form of a report, presentation or design (A.Stojcevski, 2008; Bell, 2010; A. Kolmos, 1996).

*Sivachandran Chandrasekaran.
E-mail address: schandra@deakin.edu.au

Problem based learning – is defined by open-ended and ill-structured problems. Ill-structured problems are those without a single correct solution. In this approach, learner chooses the problems and methods to be used. The project work concerns about both problem analysis and problem solution. The teacher acts as a facilitator to facilitate the learning process rather than providing the knowledge. Students have to work out their own learning requirements. Problem solving is a component of the problem-based approach. The goals of PBL include helping students to develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation (Erik De Graaff and Anette Kolmos, 2007; Erik De Graaff and Anettee Kolmos, 2003; Michel, 2009).

Problem oriented project based learning – is an educational philosophy of creating a constructive learning environment in which students are able to integrate sustainable design into engineering. The project work is considered to be the pathway for students to gain interdisciplinary knowledge and development of skills in order to tackle the sustainable design challenges. Kolmos (author of POPBL) states that most of the engineering institutions in Europe are changing their traditional curriculum due to the expectations of new engineering skills required by the Accreditation of European Engineering Programmes (EUR-ACE). The traditional model is lecture centred, discipline oriented, and based on basic and applied technical knowledge. This particular approach is used to change teaching mode to learning mode, which incorporates interdisciplinary, student-centred, self-directed learning in the new model. Kolmos also states that the task of the teacher is altered from transferring knowledge into facilitating the learning process of the students (Hung., 2008; Lehmann, 2008; Moesby).

Design based learning (DBL) – is a self-directed approach in which students initiate learning by designing creative and innovative practical solutions which fulfil academic and industry expectations. Integrating design and technology tools into science education provides students with dynamic learning opportunities to actively investigate and construct innovative design solutions. A design based learning environment helps a curriculum to practice 21st Century Skills for students such as hands-on work, problem solving, collaborative teamwork, innovative creative designs, active learning, and engagement with real-world assignments. By engaging students in learning design, DBL provides an opportunity to experience individual, inventive and creative projects that initiates the learning process in relation to their preferences, learning styles and various skills (Doppelt, 2009; S.M. Gómez Puente, 2011; Wijnen, 1999).

3. Project oriented design-based learning

Accrediting bodies such as the Accreditation Board for Engineering and Technology (ABET), Engineers Australia (EA), as well as the European Accreditation of Engineering Programs (EUR-ACE), all specify that Design is an essential element of graduate outcomes for an engineering program(ABET, 2012-2013; EA, 2012; ENAEE, 2008). Different types of problems exist in engineering and design problems are most important that attracts young, imaginative engineers. Design is not restricted to engineers, who are not only professional designers. Everyone designs who devises courses of action aimed at changing existing situations into preferred ones.

Studying engineering involves not only learning scientific knowledge and technological skills; it also involves learning the language, established practices, beliefs, and professional values of engineering culture that makes a student to be an engineer. The problem solving is one of the important skills for students. Therefore the goal of all engineering programs is to teach problem solving skills to educate students as professionals. Industry is looking for professionals with design knowledge, which is integrated with creative and innovative interdisciplinary thinking (University, 2012). The project-oriented design based learning framework will focus on skills such as innovation and creativity in the engineering discipline.

To deal with problems and to find the solution for the problems is an essential quality for a professional. Therefore curriculum needs to educate and prepare the students to be a problem solver. With different learning styles students are able to express their skills and talents through working on projects. By integrating design and technology tools into engineering education, the aim is to provide students with dynamic learning opportunities to actively investigate and construct innovative design solutions. The project-oriented design based learning approach is focused on curriculum renewal to practice innovation and creativity for students learning to solve design problems through projects in engineering education (Chandrasekaran, 2012b, 2012c, 2013). This approach aimed to have exposed noticeable changes within the performance and knowledge of students, especially when breaking out of traditional cultures and introducing creative ideas.

4. Methodology

This paper is a part of a continuing process of a research project, which analyses teaching and learning approaches in engineering education. The aim of this research paper is to investigate the staff perspectives in design based learning in engineering education. The face-to-face interviews are based on qualitative questions that are analysed and presented in quantitative form. The questions covered here are designed to determine the staff perspectives on design based learning through their level of experience from 1st year to final year. An interview question set was asked to each staff that teaches and performs research in engineering design. The research assistant who involved in the project conducted the interviews and data collected are anonymous and non-identifiable.

The results outlined are from the staff own experiences and present give various views, which include staff knowledge and expectations from which in turn can informs the school to implement a design centred education. This research work is carried out in line with the ethics approval process and procedures. The questions were prepared to identify the challenges in teaching and learning and in particular to investigate the staff perspectives on the practice of design based learning. From these results, the research will lead to new teaching and learning approach, which enhance student-learning outcomes.

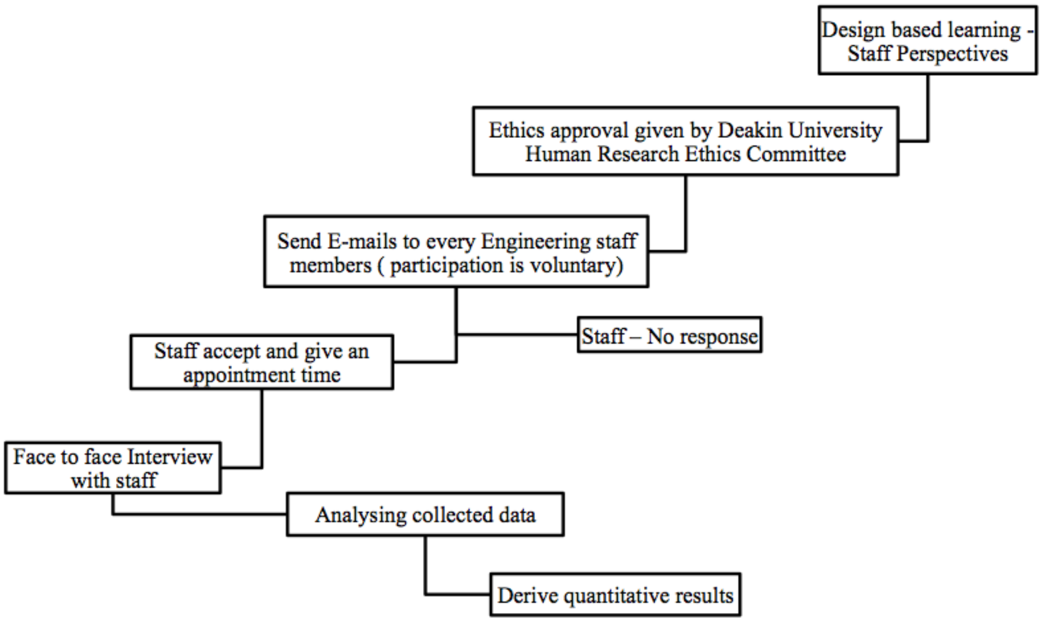

Figure 1. Staff interview process

Figure 1 shows the flowchart of the process of staff interviews conducted by the research assistant involved in this research. In line with the ethics approval process and procedures, research assistant send an individual E-mails to every staff member in the School of Engineering. When a staff given an appointment time, the research assistant will conduct the face-to-face interview. An interview question set was asked to each staff that teaches and performs research in engineering design. The data collected are anonymous and non-identifiable. The collected data are analysed to derive a quantitative outcome that shows the staff perceptions on design based learning.

The staff Interview questions is listed below:

Q1: Define design based learning (DBL)?
Q2: What does engineering design mean to you?
Q3: Are aspects of engineering design taught in your unit? If yes, How?
Q4: Do you see engineering design as an essential learning element of an engineering program? If yes, why?
Q5: What do you think of some of possible ways to teach design?
Q6: Does your curriculum involve design-based learning through projects?
Q7: Could you please list some of the skills attained by students through DBL in your unit?
Q8: How can engineering design projects helps to collaborate with industry?

5. Results

Design based learning is one of the most important fields of engineering learning that the school of engineering at Deakin believes that it would enhance the learning experience for students. The school of engineering is currently using these methods at different levels in various units. There is a need to verify these methods and to identify the best practice in these methods to ensure the best possible learning experiences for the students. The staff members in the school of engineering participated in the face-to-face interview about design based learning. From the staff perspectives, it is possible to access the current levels of benefit to the engineering student. The results shown below helped the school to help the staff to improve their teaching experiences at the school of engineering at Deakin University.

Figure 2 illustrates the staff perspectives about design based learning means, a large number of staff responses (40%) define DBL as learning design through projects, 20% define DBL as learning through design activities, 20% defines it as focus on aspects of design and 20% defines DBL as active learning process.

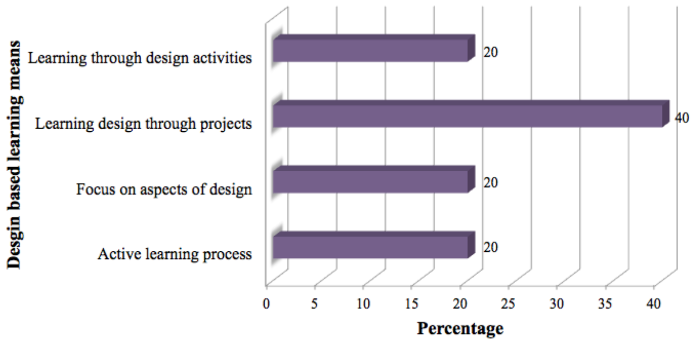

Figure 2. Staff perspectives on Design based learning

Overall staff perceptions about design based learning shows that every staff member got a unique way of teaching and learning process, which focused on learning design in various aspects. As a part of the process towards identifying what DBL means to staff, it was important to find out how staff define engineering design means. Figure 3 shows that a large number of staff responses (30%) define engineering design is to create or design something benefit to the society, 20% define engineering design as a structured approach to engineering problem solving through projects, 20% defines that using a design tool to engineer a creative solution, 20% of staff defines engineering as going through a design process and 10% defined it as use existing knowledge to create new things.

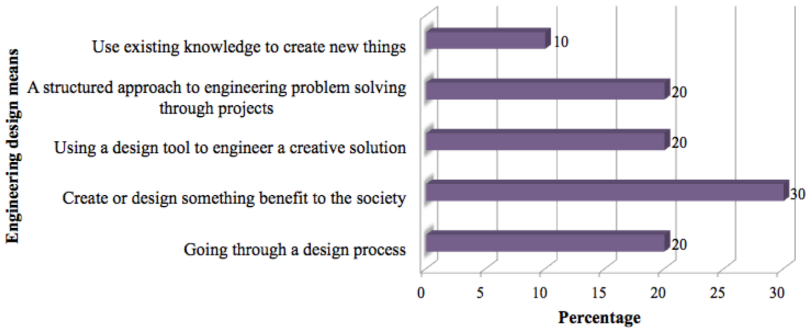

Figure 3. Staff perspectives on engineering design

In common, all engineering staff members express that engineering design is an essential element of an engineering program.

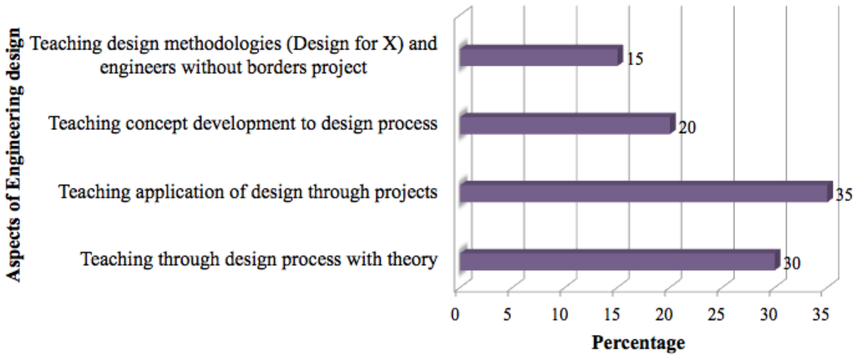

Figure 4. Aspects of engineering design taught by staff

When the staff are asked about aspects of engineering design taught in their units, figure 4 illustrates that 35% of staff say that they perform it by teaching application of design through projects, 30% mentioned it by teaching through design process with theory, 20% says aspects of engineering design taught by teaching concept development to design process and it is interesting to see that 15% teaching design methodologies (Design for X) and engineers without borders project.

Table 1. Staff perspectives on engineering design as an essential element

S.no	Engineering design as an Essential element	%
1	Agree	15
2	Mostly agree	85

Table 1 show that 15% of staff member agree and 85% of staff member mostly agree that design as an essential element of an engineering program. These staff members are working in the School of engineering in Deakin University who teaches and performs research in engineering design. The staffs were also asked about their perception on possible ways to teach design. Table 2 illustrates staff perspectives about possible ways to teach design such as team based learning, activity based learning, analytical thinking and self-directed learning. From Table 3 it can be seen that majority of the staff strongly accepts that their curriculum involves DBL.

Table 2. Staff perspectives about possible ways to teach design

S.no	Possible ways to teach design	%
1	Team based learning	15
2	Activity based learning	35
3	Analytical thinking	20
4	Self-directed learning	30

Table 3. Staff perspectives about curriculum involves DBL through projects

S.no	Curriculum involves DBL	%
1	In transition status	5
2	Possible yes	20
3	Strongly yes	75

Table 4 illustrates the staff perspectives on skills attained by students through DBL. Majority of the staff members mentioned that creativity, learning by doing, problem solving, self directed learning are the most important skills attained by students through design based learning in their curriculum. In addition Figure 4 shows staff perception on collaboration of academics with industry.

Table 4. Staff perspectives on skills attained by students

S.no	Skills attained by students through DBL	%
1	Team work & Communication	30
2	Learning by doing	45
3	Problem solving	45
4	Self-directed learning	40
5	Creativity	70

Figure 5 shows that majority 30% of staff members recommend that practicing and improving design projects in universities helps engineering design projects to collaborate with industry. The least 10% of staff says that collaboration of academics with industry will help students' exposure to real world problems.

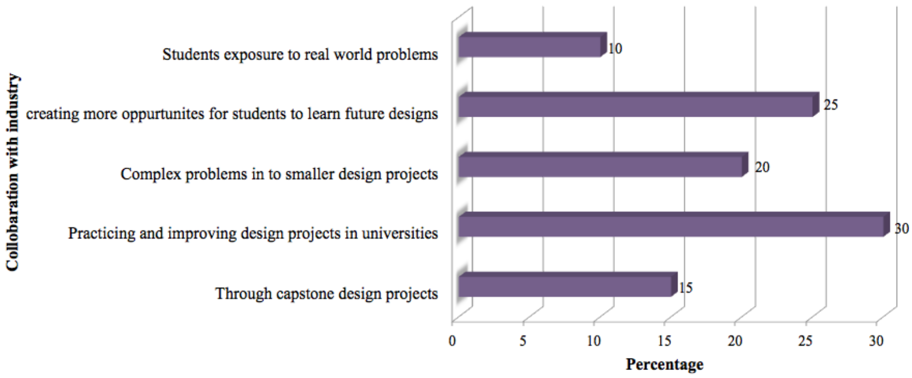

Figure 5. Staff perspectives on collaboration of academics with industry

Some of the qualitative comments from the Deakin University engineering staff members on design based learning (DBL) are listed below.

DBL is about where students taken a project or task to be active in their learning by finding a solution for a problem. Where the solution is known or not known but it is about going through a process of design to have a tangible outcome.
DBL is a part of learning and teaching process. It introduces a problem to design to get a solution for an end user and as well as the environment. DBL is to emphasize engineering principles through design.
DBL is the learning process that happens through the process of designing something or working through a project. Taking an idea something engineered and well defined. Teaching students the fact that an engineering product is well defined, well thought and processed thru many steps of refinement to get a stage for specific purpose.
DBL is using design principles whether that's 7 steps or 8,9 steps design process to facilitate student learning via the conduction of the project (research or design project or project around learning itself).
Everything in engineering is DBL. Every learning exercise is design based or development based.
DBL is an active learning process where student given a design problem they need to solve which they have to come up with ideas or workout what they need to find out to actually able to solve it. Apply design processing in doing it to find out the solution.
DBL is something appropriate for engineering course, or engineering course focusing on some aspects of design or industrial design where the classroom tasks is centred around the designing something a product and the background knowledge required to pick up the whole things on.

5. Professional development

In many cases, academic staff are responsible to drive and set high expectations in their classrooms. Sometimes staff are expected to teach subjects outside their expertise. In some cases, academic staff could be experiencing lack of confidence in their ability to teach subjects and at the same time are not willing to seek professional development activities. These professional development opportunities provide staff with valuable opportunities to enhance their personal teaching qualities, which helps them to achieve and follow a successful learning and teaching process. At Deakin University, staff are encouraged to practice teaching and learning approaches that influence, motivate and inspire students to learn. Deakin Learning Futures provides a range of opportunities, events and services for staff to enhance their capability to be effective educators. In order to enhance continuing students engagement in learning and provide active learners in the classroom, teachers need to teach each other through professional development workshops (Malinda Schaefer Zarske, 2004).

6. Conclusion

The engineering teaching staff at Deakin University seem to have an adequate understanding of DBL, which are illustrated from the results shown above. This is encouraging to the School of Engineering, which will enhance student learning and staff teaching processes to better align with the learning and teaching model. This paper is a part of an ongoing research that helps to foster curriculum development in student understanding and engagement. Project Oriented Design Based Learning is set to have a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, creativity, innovation, and problem solving which increases their motivation and engagement. It is a challenging task for academic staff to implement a PODBL approach and integrate technology into projects in meaningful ways.

Acknowledgements

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References

ABET, Accreditation board of engineering and technology. (2012-2013). Criteria for accrediting engineering programs.

Chandrasekaran, S., and Stojcevski, A., Littlefair, G., Joordens, M. (2012a). *Learning through Projects in Engineering Education*. Paper presented at the Eurpean Journal of Engineering Education Conferences (SEFI 2012), Thessaloniki, Greece.

Chandrasekaran, S., and Stojcevski, A., Littlefair, G., Joordens, M. (2012b). The Process of Design Based Learning: A Students' Prespectives. Australasian Association of Engineering Education (*AAEE)*, Melbourne, Australia.

Chandrasekaran, S., and Stojcevski, A., Littlefair, G., Joordens, M. (2012c). Project Oriented Design Based Learning: Aligning Students' Views with Industry needs. Paper accepted at International Journal of Engineering Education (*IJEE)*.

Chandrasekaran, S., and Stojcevski, A., Littlefair, G., Joordens, M. (2013). *Accreditation Inspired Project Oriented Design Based Learning curriculum for Engineering Education*. Paper accepted at 2nd International Engineering and Technology Education Conference (IETEC), Ho Chi Minh City, Vietnam.

Doppelt, Y. (2009). Assessing creative thinking in design-based learning. *International Journal of Technology and Design Education*, 19(1), 55-65.

EA. (2012). Engineers Australia. Stage1 competency standard for professional engineer. Australia.

EUR-ACE. (2008). European accreditation of engineering programmes. EUR-ACE Framework standards for the accreditation of engineering programmes.

Gómez Puente, S. M., Van Eijck, M., and Jochems, W. (2011). Towards characterising design-based learning in engineering education: a review of the literature. *European Journal of Engineering Education*. 36(2), 137-149.

Hung, W. Jonassen.D, H., Liu, R., (2008). Problem Based Learning. Handbook of research on educational communicationsand technology.

Kolmos, A. (1996). Reflections on Project Work and Problem-based Learning. *European Journal of Engineering Education, 21*(2), 141-148.

Kolmos, A., and Graaff E, De. (2007). *Management of Change*: Sense Publisher.

Kolmos, A., and Graaff E, De. (2003). Characteristics of Problem-Based Learning. *Journal of Engineering Education*, 19(5), 657-662.

Lehmann, M., Christensen, P., Du, X., Thrane, M. (2008). Problem-oriented and project-based learning (POPBL) as an innovative learning strategy for sustainble development in engineering education. *European Journal of Engineering Education*, 33(3), 283-295.

Michel, J. (2009). Management of Change-Implementation of Problem-based and Project-Based Learning in Engineering. *European Journal of Engineering Education, 34*(6), 606.

Moesby, E. (2005) Curriculum Development for Project-Oriented and Problem-Based Learning (POPBL) with Emphasis on Personal Skills and Abilities. *Global Journal of Engineering Education, 9(2), 121-128.*

Stojcevski, A., and Veljanoski, R. (2008). Electrical Engineering & PBL: From a Teacher-Centred to a Student-Centred Curriculum: Victoria University.

Stephanie, B. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *A Journal of Educational Strategies, Issues and Ideas*, 83(2), 39-43.

University, Deakin. (2012). Deakin Design Forum : Industry and Academia needs: Deakin University, Australia.

Wijnen, W.H.F.W. (1999). Towards Design-Based Learning. *Educational Service Centre*: Technische Universiteit Eindhoven.

Zarske, M., Sullivan, J., Carlson, L., and Yowell, J. (2004). *Teachers Teaching Teachers: Linking K-12 Engineering Curricula with Teacher Professional Development.* Paper presented at the American Society of Engineering Education.

The many roads to Problem-Based Learning: A Cross-Disciplinary Overview of PBL in Asian Institutions

Virginie Servant [ab] *

[a]*Director, Promethea Education, 536457 Singapore, Singapore*
[b]*Doctoral Candidate, Erasmus University Rotterdam, Burgemeester Oudlaan 50,*
3062 PA Rotterdam, The Netherlands

Abstract

Since the late 1970s, Asia has been adapting pedagogical breakthroughs to the unique context of its higher education institutions. In the late 1990s and 2000s, an explosion of interest in Problem-Based Learning swept the continent: hundreds of schools across dozens of fields put forward their versions of PBL. While the traditional ties with Western institutions continue to serve as an inspiration, many Asian institutions are now claiming a lead role in a new, very Asian way of carrying out the methods and philosophy of PBL – and in so doing, inspiring other Asian institutions to follow suit. This paper retraces the footsteps of PBL in Asia before offering a typology of the trends in PBL in Asia through selected examples, across cultures and disciplines.

Keywords: Problem-Based Learning, Asia, Cross-cultural comparisons, Cross-disciplinary comparison;

1. Introduction

Given the recent explosion of interest in PBL across the continent, an exercise in mapping out the use of Problem Based Learning (PBL) in Asia is both interesting and timely. Indeed, since the pioneering days of PBL in Asia in the early 1990s, hundreds of schools have moved to adopt some form of PBL, across dozens of fields of academic study, in so many different forms and variations that to depict each type of curriculum individually would be a momentous (and possibly futile) task. However, there are certain common trends in the implementation of PBL across the continent can be grouped into broader categories.

This paper proposes to identify the major trends in PBL in Asia through a typological approach, as this gives the best cross-disciplinary perspective, using the typology of Kwan & Tam (2009) as the basis for classification. There are now hundreds of higher education programs across Asia which claim to be using some form of PBL – however, given that little information is available on the vast majority of these, the examples in this paper have been chosen for their representativeness of the general trends, and for the quantity and quality of data available on these programs. The data used to support this paper was collected by the author through fieldwork at the institutions between February 2012 and November 2012, and originally used to write country by country overview reports, but had not been synthesized before. During these institutional visits, the author conducted a series of semi-structured interviews with faculty and students, observed the tutorials process, collected relevant materials such as unit manuals and problem scenarios, visited the premises including laboratories and tutorial rooms, and sometimes attended presentations and Q&A sessions with the faculty. Where ever possible, the data was cross-referenced with published materials such as books, monographs, journal articles and reports, as well as unpublished materials such as conference proceedings, reports and other documents sent to the author by the institutions or freely available on conference websites.

2. A brief history of PBL in Asia

It should come as no surprise that PBL in Asia began with medical education, since the first “PBL” program on record came about in the late 1960s at McMaster University’s new Medical School, in Hamilton, Ontario. The principles laid out by Dr. John Evans and his Education Committee (Spaulding, 1991) revolutionized medical education in a shake-up that called for the abandonment of traditional, compartmentalized, lecture-driven learning in favor of integrated, systems-based, small-group tutorials centered on biomedical problems as the trigger for learning (Barrows & Neufeld, 1974; Hamilton, 1976). This educational experiment sent ripples throughout the world of medical education. Although early developments happened mainly in Europe and North America, a new medical school at University Sains Malaysia seized the opportunity of a fresh start to test out the methods of PBL in its own curriculum in 1979 (Zabidi & Fuad, 2002). However, the real impetus for implementing PBL medical education in Asia came in the early 1990s, when several pioneering institutions attempted the method in their programs. The move was all the braver that all of these institutions had pre-existing curricula and would therefore have to convert rather than start from scratch. Seemingly independently, in the early 1990s, Tokyo Women’s Medical University (Yoshioka et al, 2005), The University of Hong Kong’s Faculty of Medicine (Kwan, 2012; Chan & Lam, 2006) and Gadjah Mada University’s Faculty of Medicine endeavored to put in place a PBL program, although all of these programs were so-called “hybrid” programs

* Corresponding Author name. Virginie Servant *E-mail address*: vservant@prometheaeducation.com

rather than comprehensive ones.

The term "*hybrid program*" can lead to some confusion – as Kwan and Tam (2009) rightly pointed out, by the strictest definition of "pure" PBL, everybody is running a hybrid curriculum, even McMaster! For the purposes of this paper, a "hybrid program" will refer to a program in which 50% or more of the student's contact time is spent in lectures, and in which the integration of sub-disciplines is either minimal or non-existent. For the purposes of this paper, institutions in which one or two courses follow a full-PBL model but are not integrated with the rest of the curriculum and constitute a minority of the courses on the program are considered "hybrid". This is what Kwan & Tam call Type 2 and 3 Hybrid Curricula (p.81). Institutions which run a program centered around PBL, with integrated thematic blocks and sufficient time granted for self-study will be categorized as "*comprehensive*" PBL programs, even if they still offer a certain number of lectures. This is what Kwan and Tam refer to as "Type 4 hybrid curricula" (p.81).

Throughout the 1990s and especially in the early 2000s, the number of medical schools utilizing PBL in Asia went up exponentially, such that, for instance, over 90% of Japanese medical schools were reported to be using some form of PBL by 2010 (Kozu, 2012), as were all 12 of the medical schools in Taiwan (Tsou, 2009) and between 50% and 70% of medical schools in Indonesia (N.M Rehatta, 2012, pers. Comm. 21st June). Governmental pressure for reform (Tsou, 2009; Teo, 2007; Satryo, 2002) is partly responsible for this push, but medical schools around the region have expressed concern about the need to modernize medical education, develop community-orientation and "soft skills" in their graduates.

Whilst medical education took the lead in implementing Problem Based Learning in Asia in the early years, programs in the field of applied sciences (Keng, 2011) and social sciences (Pearson, 2005) began to surface in the late 1990s. The main push for PBL in Asia took place in the 2000s, during which the number of programs and the fields of application exploded. PBL programs could be found in almost every area of health sciences; the first law programs using PBL were set up in Indonesia; diverse fields such as architecture and clinical psychology (Lee *et al*, 2009) began developing their own programs, often inspired by the faculty or school of medicine within the same institution. Networks developed which endeavored to structure the dialogue on PBL in the region, such as the Asia Pacific Association for PBL in the Health Sciences (APA-PHS) and the Asia Pacific Conference on PBL (APC-PBL) – which now jointly run a bi-annual conference on PBL in various countries around the region. As the method grew more popular, so more radical innovations began to spring out of the Asian educational scene. In 2002, the "One-Day, One-Problem" model was developed for a polytechnic institution in Singapore; in 2006, a Japanese Health Sciences institution built a PBL curriculum which integrated problems across all of its faculties. Finally, around the turn of the millennium, the Project-organized approach to PBL began making its breakthrough in applied sciences (Chin *et al,* 2012) and information systems engineering (Tozawa, 2009). The push for PBL in Asia also had its casualties, with some programs falling by the wayside, particularly in the Philippines (Tan, 2012, Pers. Comm. 27th March) and Singapore (Samarasekera, 2012, Pers. Comm. 10th April).

The following overview shows the great diversity in country of implementation, field of application, period of implementation and the type of curriculum (Table 1).

Table 1. Sample of PBL curricula in Asia

Institution	Country	Field of Application	Year of Implementation	Type of Curriculum
University Sains Malaysia	Malaysia	Medicine	1979	Comprehensive
Tokyo Women's Medical University*	Japan	Medicine	1990	Hybrid
Gadjah Mada University*	Indonesia	Medicine	1992	Comprehensive (since 2002)
Ateneo de Zamboanga	The Philippines	Medicine	1994	Comprehensive
The University of Hong Kong*	Hong Kong	Medicine	1997	Hybrid
Temasek Polytechnic*	Singapore	Applied Sciences	1998	Hybrid
The University of Hong Kong*	Hong Kong	Social Work	1999	Hybrid (since 2000)
Airlangga University*	Indonesia	Medicine	1999	Hybrid
National University of Singapore*	Singapore	Medicine	1999-2010	Hybrid
Fu Jen Catholic University*	Taiwan	Medicine	2000	Comprehensive (yrs 3-4)
University Santo Tomas*	The Philippines	Medicine	2001-2006	Hybrid
Republic Polytechnic*	Singapore	Applied Sciences	2002	One-Day, One-Problem
Fu Jen Catholic University*	Taiwan	Clinical Psychology	2003	Hybrid
Universiti Teknologi Malaysia	Malaysia	Engineering	2003	Hybrid
Showa University*	Japan	Health Sciences	2004	Interprofessional
Gadjah Mada University*	Indonesia	Law	2006	Hybrid
Udayana University*	Indonesia	Law	2008	Comprehensive
Advanced Institute of Industrial Technology	Japan	Information Systems	2010	Project-Based

Singapore Polytechnic*	Singapore	Mathematics & Science	?	Project-Based

In order to present the best possible range of programs in a concise form, this paper will classify the programs from the most common type to the least common type. To begin with, we look to the popular hybrid models of PBL. From there, we examine the best-practice in "near-full" or "comprehensive" PBL curricula. Although these are far fewer in number, they form the forefront of success stories of PBL in Asia. Finally, we analyze a sample of up and coming models: the inter-professional model and finally, the "One-Day, One-Problem" experiment.

3. The "Hybrid" PBL model

Almost all of the programs in the pioneering years of PBL in Asia were "hybrid programs" in the sense that they combined elements of a traditional curriculum, namely discipline-based lectures, and elements of PBL, namely the small-group, problem-based tutorials. Today, it is still the case that the overwhelming majority of school that use PBL in Asia do so following a hybrid mode.

3.1. "Hybrid" PBL for Medical Education

There are hundreds of hybrid PBL programs in medical education around the region. As an illustration, Airlangga University's Faculty of Medicine, which the author briefly visited in June 2012, is representative of the general trend. Like in many other Indonesian medical faculties, problems with the quality of the Faculty's graduates emerged at the turn of the century. Having observed the success of Gadjah Mada University's transition to PBL, the School sent a team there for inspiration. The first hybrid PBL class at the university opened its doors to students in September 2000.

However, neither the Vice Dean for Educational Affairs nor his team of medical educators felt that a comprehensive PBL curriculum was suited to the needs of this established medical Faculty. As a result, only 30% of contact hours were allocated for PBL. The rest remained as traditional, discipline based lectures, with little or no integration between the courses. The Faculty also conducts skills laboratory classes independently of the PBL and lecture-based courses. This time allocation between PBL and traditional courses is fairly representative of Hybrid curricula in medical education across the region. Generally, the mark for what C.Y. Kwan has labeled "Type 2" and "Type 3" hybrid curricula (Kwan & Tam, 2009) – that is, curricula that use PBL to support the traditional methods of learning – seems to be between 40% and 20% of time allocation in the curriculum for PBL. Sometimes, programs may just be borrowing the skills-based laboratory exercises from PBL, as well as certain examination methods such as the Objective Structured Clinical Examination (OSCE) – without using the tutorial method. The OSCE has certainly been one of the more popular imports from Western medical institutions. Kwan describes so-called "hybrid" programs, the curriculum of which comprises of less than 10% of time allocated to PBL, as "decorative" (p.81). This is appropriate enough that we need not concern ourselves with such programs in an overview of PBL in Asia.

Given that the Faculty of Medicine of Airlangga University is a long-standing institution, some re-adjustments were needed to fit in small-group work. Practically speaking, rooms had to be accommodated for the new method, which means that large rooms were subdivided with partitions to allow for 10-person discussions. Beyond mere physical adaptations, the Faculty also had to invest in a tutor-training program for its members of faculty – a five-day training program including a theoretical component and a tutorial simulation were put in place. This type of initial tutor training program is fairly common in these Hybrid PBL courses, especially in medical education. The University of Hong Kong's medical school follows a similar (if shorter) training pattern (Chan & Lam, 2006). From observation, it appears that hybrid programs in medicine place more emphasis on tutor training that hybrid programs in other fields of study in the region. However, once the initial training is completed, on-going training seems to be limited. A refresher course may be provided annually, as is the case at Airlangga, but where faculty time is limited and PBL is only a small component of the program, tutor training is usually relatively restricted.

3.2. *Case study of a "hybrid" program in Applied Sciences*

The use of a Hybrid model of PBL for applied sciences education in Asia can be chiefly found in Singapore (Tan, 2005; Tan, 2000) and in Hong-Kong (Forrester & Chau, 1999; Tang *et al*, 1997) polytechnic institutions. Like the hybrids in medical education, these institutions use PBL as part of a wider range of pedagogies, some of which are more traditional. One of Singapore's Polytechnic institutions has been using PBL in its hybrid form since 1998 (Keng, 2011). The institution in question, which the author briefly visited in April 2012, sought input from a variety of actors in the PBL scene, including the late McMaster professor Howard Barrows (Hee, 2005, p.35). However, it was decided from the outset that PBL should only be mandatory in one the course for each diploma program. Other methods of teaching and learning would be used for the rest of the program. In a typical week, students might spend four hours in small group tutorials. The rest could be spent in laboratories, lectures or other forms of instruction.

The quantity and length of problem-scenarios varies, but in a given program, students can take up to five PBL subjects in eight weeks, with each problem lasting between three and six weeks, which some students find somewhat overwhelming (Keng, 2011). The institution promotes a seven-step problem-solving path, which is not unlike the original seven-jump method coined by Maastricht University (Schmidt, 1983), although in this case, the self-study period takes place at the fifth, rather than the sixth step. In this pathway, the identification of learning issues is consolidated in stage 4 (whereas it is split across two "jumps" in the Dutch method) and the process of synthesis and application is divided from the process of reflection and feedback (whereas it is grouped in one final "jump" at Maastricht University).

Whilst traditionally, scaffolding in the PBL process is generally associated with the use of a "more knowledgeable person" (Kim & Hannafin, 2011, p. 407) – the tutor – as the principal scaffold, the institution in question has also been using hard scaffolds to support the problem based learning process. Hard scaffolds are aptly defined by Brush and Saye (2002, p.2) as "static supports that can be anticipated and planned in advance based upon typical student difficulties with a task". In this context, the students use a FILA sheet (Keng, 2012), which stands for "Facts, Ideas, Learning Issues, Action Plan", to tackle the problem scenarios. This tool is particularly emphasized for new students who are not familiar with the Problem-Based Learning process. In later years, students are able to take a more flexible approach and rely more heavily on other forms of scaffolding, including peer-scaffolding (Lee, M. 2012. Pers. Comm. 17th April).

Assessment in this model combines a series of formative and summative evaluations. As an example, in a given applied sciences subject, the formative part of the assessment consists in verbal feedback from tutors, open peer feedback, and optional consultations with tutors after the summative marks are given out. This takes place throughout the problem-solving process. The summative part of the assessment consists in a grade for performance during a 30 minute group interview, a mark for the students' completed FILA sheet, research summary notes and submission of meeting minutes, followed by group oral presentations (Keng, 2012).

This polytechnic institution has placed a strong emphasis on its involvement in PBL, promoting it prominently in publications and in its own Center for Problem-Based Learning. However, the director of the Center made it clear that this institution promotes using a mix of pedagogies (Lee. M, 2012, Pers. Comm. 17th April).

4. Best-practice in "Comprehensive" PBL programs

While there are hundreds of Hybrid PBL curricula in medical education around the region, the number of cases of "comprehensive" or "Type 4" (Kwan & Tam, 2009) PBL curricula is far more limited. Those that do implement such a curriculum serve as best-practice exemplars for those studying PBL, even though the amount of academic publications available in English on these curricula is limited.

4.1. "Comprehensive" PBL curricula in Medical Education

In Indonesia, Gadjah Mada University (UGM)'s Faculty of Medicine, which the author visited in May 2012, has been implementing PBL since 1992. Although it originally undertook a "Hybrid" PBL approach, its curriculum has moved towards a comprehensive form of PBL since 2002, initially in its international program, and later in its entire curriculum. UGM drew inspiration from Maastricht University, and certain particularities of the Dutch method can be found there, such as the "Skillslab" and "Block-book" (Mundo, 2012). In Taiwan's Fu Jen Catholic University, which the author visited it November 2012, the inspiration for the comprehensive PBL curriculum which began at the School of Medicine in 2002 (Tsou *et* al, 2009) came from a variety of influences, including former McMaster professors and the university of Maastricht's curriculum (p.284). Interestingly, UGM had to contend with a pre-existing Faculty of Medicine in a time where PBL was not the norm whereas FJCU established a new school of medicine in a context of governmental support for the method (p.283). As such, whereas UGM progressively built up to a full PBL curriculum between 1992 and 2002 (Prakosa, J. 2012, Pers. Comm. 3rd May), FCJU was able to implement a near-full PBL curriculum in the 3rd and 4th year of its studies almost immediately. Herein lies another difference between the two institutions: the Faculty of Medicine at Gadjah Mada provides a five-and-a-half year program including two years of clinical rotations, during which the first three and a half years are spent in a block-based PBL program. By contrast the first two years at Fu Jen are spent studying "Common Education & General Sciences" (Tsou, 2012), whereas the fifth, sixth and seventh years are spent in clinical clerkships and internships, leaving only the third and fourth year for the use of biomedical problems in small-group tutorials.

The principles underlying both curricula are otherwise similar: an integrated approach to learning, where biomedical problems, clinical skills practicum and lectures are integrated around organ-systems and the life cycle. Both curricula make use of "block books", or "unit manuals" which serve as a guide to students and tutors. The tutors are either basic scientists or clinicians, working with groups of 6-10 students in tutorials which last between 2 and 3 hours, twice a week. The problems are generally patient cases written by competent clinicians.

From the point of view the study of PBL in Asia, the most interesting point about both of these programs is the channelling of a learning philosophy which truly reflects the goals of PBL. Both programs are pushing for the core principles of PBL as defined by Chng, Yew and Schmidt (2011):

> (1) the use of authentic problems for students to work on without prior preparation so as to achieve the required knowledge, (2) students initiate their own learning whereby students work in (3) small collaborative groups under the (4) flexible tutelage of a tutor who guides the learning process. As problems are used as the starting point for learning, (5) the number of lectures are limited and (6) students would have sufficient time for self-study.

Both programmes limit their lecture times to 4 or 5 hours per week, which serve as support for the problems rather than the other way around. In both cases, the tutors receive training in facilitating, rather than lecturing students during tutorials, and tutorial observation in both institutions indicates that this is being applied in practice. Furthermore, both programmes are committed to providing an integrated learning environment – that is, where the biomedical problems, the skills training sessions, the laboratory-based work and the lectures all fit around a central unit theme, rather than compete with one another for time and resources, as can be the case in Hybrid curricula.

The success of these programmes comes as both the government of Indonesia (Nederstig & Mulder, 2011) and of Taiwan (Tsou, 2009) move in support of student-centered learning. In both cases, interviewees reported strong leadership pushing for change within the school and high buy-in from faculty. These examples show that although the Hybrid model largely dominates the medical education scene in Asia, successful implementation of "Type 4" curricula is possible.

4.2. Cases of best-practice outside of medical education

Law schools in Indonesia have also been feeling the pressure to reform to a more competence-based curriculum – as such, some of them have turned to PBL, with the assistance of foreign partners, as a means of implementing the governmental requirements. The author visited the Faculty of Law of Udayana University in June 2012, where a collaboration opened in 2008 with the Faculty of Law of Maastricht, aiming to "strengthen the Faculty of Law" of the Balinese institution (Mundo, 2012). This translated as a complete curriculum overhaul in which a new comprehensive PBL program was designed, modelled on the Dutch methods of PBL, to a large extent. This overhaul made the Faculty of Law of Udayana University the first in Indonesia to adopt a "Block-Based" approach across its entire curriculum, complete with block-books and lectures which fit into the block's theme. However, given that the lectures come *before* the tutorial session, one might wonder whether this program sits squarely within the category of "Type 4" curricula, or whether it would be more representative of a "Type 3" hybrid model. The Faculty made it clear that the purpose of these lectures was to serve as an "introductory reflection" to a topic rather than to spoon-feed answers to the students (Supasti, K. 2012, Pers. Comm. 14^{th} June) The spirit of PBL is clearly present in this institution, with a revamped library, new tutorial rooms equipped with smart boards and computers, a new information system designed to cater to the e-components of a PBL programme – including access to an online journal database – and new computer labs. The finishing touches to the programme were only put in place in 2012, so it remains to be seen what shape it will take after a few years of operation.

Other best-practice examples of the full implementation of PBL in selected courses (rather than at curriculum level) can be found in engineering in Malaysia (Khairiyah *et al*, 2004, 2005), among other fields of study – but whilst these programs are in themselves a tribute to the progress of PBL in Asia, the most striking development has been the establishment of new and radical takes on the classic PBL model.

5. New models for PBL in Asia

Beyond the standard typology of "hybrid" and "comprehensive" PBL curricula, some new models are appearing around the region. Most of these programs are recent inceptions, experimental in nature, and confined to one or a few institutions. To finish this overview of PBL in Asia, we choose to focus on two such examples: the Inter-Professional approach and the "One-Day, One-Problem" model. These are only examples, and we could also have opted to look at Project-organized PBL (Kolmos, 1996) in the region as it is applied in Singapore (Chin *et al*, 2012) or in Japan (Tozawa, 2009; Matsuzawa & Ohiwa, 2007).

5.1. The Inter-Professional Approach

The author visited Showa University in August 2012, which is one of Japan's larger private health sciences institutions. It began to experiment with Hybrid-PBL in 2004, in its Faculty of Dentistry. By 2006, all four of its Faculties converted using a Type 2 or Type 3 curriculum. What is truly unusual about the case of Showa University is the choice made by the institution as a whole to integrate its PBL curriculum across the four disciplines (dentistry, medicine, pharmacy and nursing & rehabilitation services) during the six years of the curriculum, particularly in the field of Inter-Professional Education. This means that throughout their time at Showa University, the students are expected to work together in small groups comprised of students from all four faculties.

The interdisciplinary problems are written by teachers from diverse disciplines in a yearly scenario-writing exercise, and then given to the students to work through using a problem-mapping system. The author was able to observe this process at the Fujiyoshida campus. Using a color-coded scheme (figure 1), which makes it easy to follow the contributions of each discipline, the students draw out the connections in the problems as they understand them from their disciplinary standpoint, and are then able to compare with the issues highlighted by the other disciplinary inputs. During the clinical years of the program, the students work with their patients in inter-professional groups, thus simulating the practice of inter-professional cooperation in a hospital environment.

One of the more striking aspects of Showa University's take on PBL, is its first-year curriculum (Imafuku *et al*, 2010, 2012). During their first year, all students are required to stay in a residential campus near Mount Fuji; they join the Tokyo campuses only in their second year. According to one of the programme's managers (Kataoka, R. 2012, Pers. Comm. 15th August), the ideas of this campus borrow from the collegial systems of Harvard University and Oxford University – by enforcing inter-disciplinarity through residential arrangements whereby four students from the four faculties share a room as room-mates for the entire first year. This peculiar structure pre-dates the introduction of PBL at the university, but as Imafuku *et al* (2010, 2012) have shown, interdisciplinary PBL complements the first-year experience for students at Showa University. This first year comprises of a heavy liberal arts and languages component, coupled with instruction in the basic sciences. Imafuku's longitudinal studies on students undergoing the program (Imafuku, 2012) show that this mode of PBL had some positive impacts on the group attitudes and communication skills of the students that he studied.

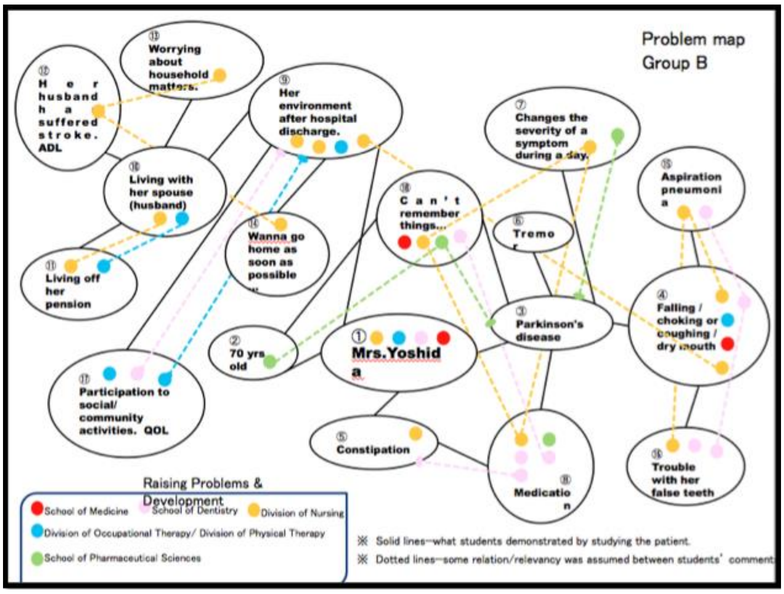

Figure 1. Problem-mapping at Showa University (Source: Kataoka, 2011)

5.2. *The One-Day, One-Problem Experiment*

The phrase "One-Day, One-Problem" was coined by a new Singaporean polytechnic institution which opened its doors in 2002, designed from the outset to work with this model. In 2006, the institution moved to a specially designed campus, the layout of which was engineering to facilitate the self-study process in a condensed cycle of one day. This was done by making the central feature of the campus into a large, open space referred to as the "Agora" at the center of which is the library. These central spaces are surrounded by pod-like circular structures, 8-9 storeys-high, that host the PBL classrooms and laboratories. The author was able to visit this campus and speak with some of its managers several times in 2012. If there is a single example of what Kwan and Tam call "pure" PBL (p.76) in Asia, it is this model, since no lectures are employed during the problem cycle – although the facilitator gives a short presentation with possible solutions to the problem during the third meeting of the day (Yew & O'Grady, 2012, p.10).

Yew and O'Grady (2012) give a comprehensive account of the structure of the One-Day, One-Problem approach to PBL. It is best summarized as follows:

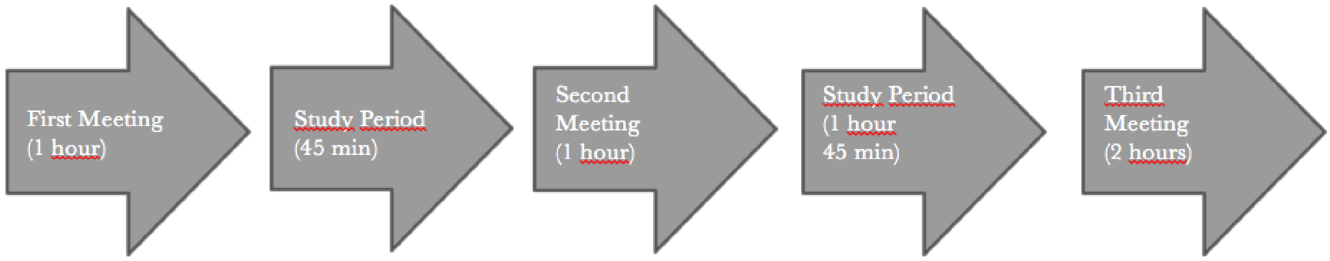

Figure 2. The Five Phases of the One-Day, One-Problem Approach to PBL (source: Servant, 2012)

Each morning, the students confront a new problem – meaning that they handle five problems every week – in groups of 25, sub-divided into groups of five which are supervised by one or two tutors. The day consists in three group meetings and two study periods. Given the facilities available, the students are expected to stay on campus during the entire problem-cycle. The students receive a daily mark for their work, and their final evaluation for a given course is a combination of 15 daily marks and 3 understanding tests. Like their counter-parts from the "Hybrid" model of PBL for applied sciences, these students make use of hard scaffolds to tackle their problem scenarios. One of the founders of the polytechnic described the rationale as follows: "The philosophy that underpins the one-day, one-problem scheme is essentially a perspective of classroom happenings, in particular, the conditions that would enable the learners in a classroom to develop in a holistic sense, while acquiring the desired knowledge and technical skills along with the humanistic orientations expressed in the desired outcomes" (Alwis, 2012, p.43).

The challenge of habituating teachers to their new role as tutors is heightened in this polytechnic institution by the fact that than 65% of all tutors come from the industry rather than an academic background (O'Grady, G., 2012, pers. Comm. 20th Feb). As such, they usually have few insights into educational theory, but a wide professional and industrial experience (Goh, 2012). Research conducted at the institution (Williams, 2012) showed that 90% of the staff either agreed or strongly agreed with the pedagogy, although they did experience difficulties in putting in into practice (p.239). Training was an important part of the institution's *modus operandi* since its inception. However, since 2009, the institution has established a three-phase tutor-training program in response to this challenge, leading to a Certificate of Completion at the end of the 104 hour-long PBL Foundation Program (Goh, 2012). In the subsequent three years, the staff pursues their training with a further 48 hours of core training, and the option of electives. The training combines elements of practice with theory of learning and aims to "immerse new facilitators in a culture of problem-solving, collaboration and reflective practice" (p.263). This setup makes it one of the most comprehensive tutor training programs in Asia. However, even with such heavy focus on tutor training, it takes between 2 and 3 years to make a good facilitator (Williams, 2012, O'Grady, G. 2012, pers. Comm. 20th Feb). The One-Day, One-Problem Approach has yet to be transferred to other institutions, and as such, the polytechnic that birthed the model is still its principal user. To what extent this model is transferrable outside of its original context has yet to be determined.

6. Many Roads to Problem-Based Learning

Two things become clear from this comparative overview of Problem-based Learning in Asia: firstly, PBL is an increasingly popular pedagogy in Asian higher education institutions. Secondly, the format of application of PBL differs both across the most popular fields of application and within those disciplines themselves. One might argue that a "Hybrid" curriculum in medicine has more in common with a "Hybrid" curriculum in engineering than with a comprehensive curriculum in medicine. Like Kwan and Tan (2009), this paper has chosen to focus on a format-based typology of the PBL curricula under scrutiny as their defining characteristic because this is the most obvious distinguishing feature, in the interest of a comparative overview. There, however, other means of classifying PBL curricula. For instance, Schmidt *et al* (2009) propose a different curriculum typology, which focuses on the intended learning outcomes of the PBL. They also highlight a point of crucial significance: the difficulty of cross-curricular comparison. Part of the reason, they claim, is that "much of the research effort and resources have been focused on curriculum-level outcome studies comparing problem-based with conventional education." (p.230) In this instance, they were talking about cross-curricular comparison in medicine, principally in Western institutions. The challenge is heightened in the Asian context, where the language of publication can pose issues for cross-cultural comparisons, but even more so in the context of *cross-disciplinary* comparisons – a field which is still largely untouched in this regions of the world where the adoption PBL is still a relatively recent phenomenon.

It is the author's experience after ten months of study and observation of PBL curricula in the region is that while the dialogue on PBL is increasingly cross-disciplinary, disciplines still play a dividing role. The explosion of interest in PBL in what is one of the world's most dynamic regions offers a unique chance for the cross-fertilization of ideas. It would not be the first time that the paths of PBL in different disciplines cross. At McMaster University, an engineering course, borrowing from the methods of instruction of the medical school, was established shortly after the start of the first PBL curriculum (Woods, 1975; 1991; 1997). More recently, the new medical school at Aalborg University has done just the opposite, borrowing the methods of project-work and integrating it with the classical medical approach to PBL. It is clear from the cases highlighted above that there are in fact many roads to Problem based learning in Asia – and whilst the different fields often seem to be running on parallel paths, it will be interesting and enriching for all PBL practitioners to come to a cross-roads at some point in the near future.

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References

Brush, T. A., & Saye, J. W. (2002). A summary of research exploring hard and soft scaffolding for teachers and students using a multimedia supported learning environment. *The Journal of Interactive Online Learning*, *1*(2), 1–12.

Chan, L. and Lam, T. (2006) *Monograph 2: Problem-based Learning (PBL): Everything you want to know and are not afraid to ask*. Hong Kong: Institute of Medical and Health Scienced Education, HKU.

Chin, L. et al. (2013) Active Learning in Singapore Polytechnic Mathematics Course. In: Chew, A. et al. eds. (2012) *The 3rd International Problem-based Learning Symposium*. Singapore: The Centre for Educational Development, Republic Polytechnic, p.27-28.

Chng, E., Yew, E. H. J., & Schmidt, H. G. (2011). Effects of tutor-related behaviours on the process of problem-based learning. *Advances in Health Sciences Education*, *16*(4), 491–503.

De Grave, W. S., Dolmans, D., & van der Vleuten, C. P. M. (1999). Profiles of effective tutors in problem-based learning: scaffolding student learning. *Medical Education*, *33*(12), 901e906.

Goh, K. (2012) A Staff Education and Development Programme to Support PBL. In: O'grady, G. et al. eds. (2012) *One-Day, One-Problem: An Approach to Problem-Based Learning*. 1st ed. Singapore: Springer, p.259-281.

Hamilton, J. D. (1976). The Mcmaster Curriculum: A Critique. *The British Medical Journal*, *1*(6019), 1–7.

Hee, Y. (2005) Problem-based learning: An Institutional Perspective. In: Tan, K. et al. eds. (2005) *Problem-based Learning: New directions and approaches.*. 1st ed. Singapore: Learning Academy, Temasek Polytechnic.

Imafuku, R. et al. (2010) *First-year students' learning experiences of problem-based learning tutorials in Japanese higher education*. [Conference Proceedings] Enhancing Experiences in Higher Education: International Conference, December 2-3. Hong Kong: Centre for the Enhancement of Teaching and Learning, HKU.

Imafuku, R. (2012) Exploring Learning Trajectories: A case-study of first year Japanese students in PBL tutorials . In: Chew, A. et al. eds. (2012) *The 3rd International Problem-based Learning Symposium*. Singapore: The Centre for Education Development, Republic Polytechnic, p.364-370.

Imafuku, R. (2012). Japanese First-Year PBL Students Learning Processes: A Classroom Discourse Analysis. In S. Bridges, C. McGrath & T. Whitehill (Eds.), *Problem-based learning in clinical education: The next generation*. Springer. p.153-194

JICA PREDICT ITS - Phase 2 (2012) *Lab Based Education*. [online] Available at: http://www.predict2.its.ac.id/index.php/lab-base-education [Accessed: 30 Jan 2013].

Kataoka, R. (2011) *Dental Education in Showa University*. [Lecture Notes] Power Point Slides. Tokyo: Showa University.

Keng, W. (2012) Examining Formative Assessment in a Problem Based Learning Subject in Applied Sciences. In: Chew, A. et al. eds. (2012) *The 3rd International Problem-based Learning Symposium*. Singapore: The Centre for Education Development, Republic Polytechnic, p.364-370.

Keng, W. (2011) Sustaining Problem-Based Learning across Temasek Polytechnic’s Curriculum: A Case Study. [Proceedings] International Conference in Teaching and Learning in Higher Education, National University of Singapore. 6-9 December, Singapore.

Khairiyah, M.Y. et al. (2005) Promoting Problem-Based Learning (PBL) in Engineering Courses at the Universiti Teknologi Malaysia. *Global Journal of Engineering Education*, 9 (2), p.175-184.

Kolmos, A. (1996). Reflections on Project Work and Problem-based Learning. *European Journal of Engineering Education*, *21*(2), 141–148.

Kozu, T. (2012) Two decades of PBL-Tutorial education: Impact and challenges in Japanese medical education. [Proceedings] 2nd Asia-Pacific Joint Conference on PBL 2012, October 24-28. Shanghai, APC-PBL and APA-PHS

Kwan, C. (2012) The Yin-Yang Dichotomy of PBL: An Asian Perspective. In: Dorsey, J. and Rangachari, P. eds. (2012) *Students Matter: The Rewards of University Teaching*. 1st ed. Springfield, Illinois: Southern Illinois School of Medicine, p.112-122.

Kwan, C. and Tam, L. (2009) Hybrid PBL-What is in a Name?. *Journal of Medical Education*, 13 (3), p.76-82.

Lee, G.H., Lin, Y.H., Tsou, K.I, Shiau, S.J., Lin, C.S. (2009) When a Problem-Based Learning Tutor Decides to Intervene. *Academic Medicine*, *84*(10), 1-7

Maastricht University - MUNDO (2012) *Indonesia - Gadjah Mada*. [online] Available at: http://www.maastrichtuniversity.nl/web/file?uuid=e99c6dda-f9c7-4f0d-9922-73c775bcf729&owner=6b84c0d4-39af-4ca5-9584-6294c4f8cdf1 [Accessed: 29 Jan 2013].

Maastricht University - MUNDO (2012) *Indonesia - Bali*. [online] Available at: http://www.maastrichtuniversity.nl/web/file?uuid=6f3b37c7-f750-4711-9ccc-a72af64cc0e8&owner=6b84c0d4-39af-4ca5-9584-6294c4f8cdf1 [Accessed: 30 Jan 2013].

Matsuzawa, Y. and Ohiwa, H. (2007) "Learning Information Systems Engineering and Its Management from Experience of a Tiny Project through University-Industry Collaboration", paper presented at *Seventh IEEE International Conference on Advanced Learning Technologies*, Niigata, 18-20th July. Institute of Electrical and Electronics Engineers..

Nederstigt, W. and Mulder, M. (2011) Competence Based Education in Indonesia: Evaluating the Matrix of Competence-Based Education in Indonesian Higher Education. [Conference Proceedings] *VETNET 2011* 13-16 September, Berlin: European Research Network in Vocational Education and Training.

Neufeld, V., & Barrows, H. S. (1974). The “McMaster Philosophy”: An Approach to Medical Education. *Journal of Medical Education*, *49*, 1040–1050.

O'grady, G. et al. eds. (2012) *One-Day, One-Problem: An Approach to Problem-based Learning*. Singapore: Springer

Pearson, V. (2005) *Problem Based Learning in a Social Work Context: Experience at The University of Hong Kong. (Departmental Monograph Series: Number 53)*. Hong Kong: Department of Social Work and Social Administration, HKU.

Satryo, S. (2002) *Higher Education Reform in Indonesia*. [online] Available at: http://www.tfhe.net/resources/satryo_soemantri_brodjonegoro2.htm [Accessed: 26 Jan 2013].

Schmidt, H. G. (1983) Problem-Based Learning: Rationale and Description. *Medical Education*, 17 p.11-16.

Schmidt, H. G., *et al* (2007). Problem-based learning is compatible with human cognitive architecture: Commentary on Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, *42*(2), 91–97.

Schmidt, H. G., Van der Molen, H. T., Te Winkel, W. W. R., & Wijnen, W. H. (2009). Constructivist, Problem-Based Learning Does Work: A Meta-Analysis of Curricular Comparisons Involving a Single Medical School. *Educational Psychologist*, *44*(4), 227–249

Spaulding, W.B, (1991) *Revitalizing Medical Education: McMaster Medical School, the Early Years 1965-1974*, B.C. Decker, Inc., Hamilton, Ontario, Canada.

Tan, K. et al. (eds.)(2005). *Problem-based Learning: New directions and approaches.* Singapore: Learning Academy, Temasek Polytechnic

Tan, O.S. et al. (eds.)(2000). *Problem-based Learning: Educational innovation across disciplines.* Singapore: Learning Academy, Temasek Polytechnic.

Tang, C., *et al* (1997). Developing a context-based PBL model. *Research and Development in Problem-Based Learning: Integrity, Innovation, Integration. PROBLARC*, *4*, 579–595.

Teo, A. (2007). The current state of medical education in Japan: a system under reform. *Medical Education*, *41*(3), 302–308.

Tozawa, Y. (2009) IT Strategy Education Through Project Based Learning. In: Kolmos, A. and De Graaff, E. eds. (2009) *Research Practice in Engineering Education*. 1st ed. Rotterdam: Sense Publishers, p.169-184.

Tsou, K. (2012) PBL works at Fu-Jen Catholic University Medical School: What now?. October 24-28, *2nd Asia Pacific Joint Conference on PBL 2012*. Shanghai: APA-PHS & APC-PBL.
Tsou, K. et al. (2009) Short Term Outcomes of a Near-Full PBL Curriculum in a New Taiwan Medical School.*Kaoshiung Journal of Medical Science*, 25 (5), p.282-292.
Williams, J. (2012) Teachers as Facilitators. In: O'grady, G. et al. eds. (2012) *One-Day, One-Problem: An Approach to Problem-based Learning*. 1st ed. Singapore: Springer, p.237-258.
Whitehead, J. (2007) Denmark's Two University Centers: The Quest for Stability, Autonomy, and Distinctiveness. *Higher Education*, 10 (1), p.89-101.
Woods, D. (1975) Teaching Problem Solving Skills. *Engineering Education*, 66 (3), p.238-243.
Woods, D.R. (1991) "Issues in Implementation in an Otherwise Conventional Programme", Chapter 12 in "The Challenges of Problem-based Learning" D. Boud and G. Feletti, eds, London: Kogan. p.122-129.
Woods, D.R., et al. (1997) "Developing Problem Solving Skill: the McMaster Problem Solving Program," Journal of Engineering Education, April, 75-91
Yew, E. and O'grady, G. (2012) One-Day, One-Problem at Republic Polytechnic. In: O'grady, G. et al. eds. (2012) *One-Day, One-Problem: An Approach to Problem-Based Learning*. 1st ed. Singapore: Springer, p.3-21.
Yoshioka, T. et al. (2005) Facilitation of Problem Finding Among First Year Medical School Students Undergoing Problem-Based Learning. *Teaching and Learning in Medicine: An International Journal*, 17 (2), 136-141.
Zabidi, H. and Fuad, A. (2002) Medical education in Universiti Sains Malaysia. *The Medical Journal of Malaysia*, 57 (Suppl: E), 8-12.

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Internationalisation of Engineering Education: Experiences from Project Based Learning Environment

Tanveer Hussain Maken[a] *

[a]*Department of Development and Planning, Aalborg University Denmark*

Abstract

This paper discussed the influence of cultural differences on the learning experiences of students in intercultural group at Project Based Learning environment at Aalborg University. The data for this paper has been drawn from a PhD project which focuses on the learning experiences of students in intercultural groups. The background of this project is the internationalization of higher education and the emergence of innovative teaching and learning methodologies which emphases student centered learning.

Keywords: Project Based learning, internationalization, cultural differences, International students;

Introduction

With the increase focus on internationalization of higher education, the mobility of international student is increasing every day. A recent report from OECD report the enrollment of international students has doubled in last ten years (OECD, 2010). The other observed trend we can see in recent years is focused on more student centered learning methodologies at universities. Mainly the trend of enrollment of international student is from developing countries to developed countries (OECD,2010), while many western universities are shifting their paradigms from teaching to learning. One of the strategies is Project Based Learning (POPBL), where student work in collaborative groups. The objective of this project is to understand the learning experience of students with different cultural backgrounds to work in groups in POPBL setting.

"An Intercultural student group at project based learning at Aalborg University comprised of student from China, Denmark, Spain and Africa. They were all supposed to work collaboratively on a project. The International students just arrived from their home countries. Their first meeting was when they were asked to form a group together with a Danish girl. The first meeting went very well. Everybody was happy to know each other. They introduce each other and told each other about their countries, everybody was hearing each other's stories with great interest. Before the end of this first dream meeting, The Danish girl suggested to make group rules. Initially other member got surprised what it means to make rules, Anyhow they started and agreed on a kind of strict rules. The Danish member was surprised to know their willingness for stricter rules! She also suggested agenda for next meeting. At the next meeting, which was actually first meeting on the project and was taking place in the project room. Nobody was there on fixed time of 8 am except the Danish girls. She was wondering about other group members. Until 10 am all members arrived and everybody gave some excuses. African and Spanish guys looked tired and they told that they were on party last night and could not wake up early. While the Chinese looked worried, initially he did not say anything, later he said he is worried about accommodation, the behavior of landlord, matters of local authorities (Kommune) and also missing his family back in China. Nobody was willing to sit in the group room to discuss project room. Danish girls mentioned about group rules, they were already broken, Danish girl could not talk more about group rules as the Spanish member said there are more important things than group rules, as a result this meeting end with the agenda for the next meetings, In next meeting again Spanish and African guys were not on time. They came with the same excuses. The group meeting started and nobody was prepared for the agenda except Danish girl again. The Danish girl was only speaking and telling about the specific details of the project. Later on Spanish feels its shame that it's all the coming from Danish girls, he started to contribute, which Danish girls could not follow, as he was speaking such things which he even don't know and it was non-academic arguments. In this whole process, the African guy took the headphone and start listening music while a Chinese member initially try to understand but later he too turned to his laptop and start writing emails and start browsing for new accommodation and part time job! Clashes started on the rules and regulation of the group. The Chinese never speak in the

* Tanveeer Hussain Maken. Tel.: +4553564222
E-mail address: ma@plan.aau.dk

group room. He never understood the importance of group work. African member always expected that other members will do his work, while the Spanish feels , he should be not worrying about group work, as he is here just for one semester and grades will not be written on his Spanish diploma, he just needs to pass. He says he already knows nobody will get fail"

The above mentioned picture shows the importance of communication and interaction among the student and it is critical in the collaborative group activities during work. The importance of this competence is not only important in such learning setting but also for future employability.

1. Importance of Collaboration and Communication across cultures

Communication aspect is very important in the context of globalization, it is important in a cross cultural setting. Similarly, communicating with peers from other cultures makes its importance very critical to understand. The Accreditation Board for Engineering and Technology (ABET) and the National Academy of Engineering acknowledges that soft skills are as important as hard skills for Engineering. In soft skill emphasis is on cross cultural communication competence. In" Engineer of 2020: Visions of Engineering in the New Century", the NAE acknowledged the competences as: 'Given the uncertain and changing character of the world in which 2020 engineers will work, engineers will need something that cannot be described in a single word. It involves dynamism, agility, resilience, and flexibility. Not only will technology change quickly, the social-political-economic world in which engineers work will change continuously. In this context it will not be this or that particular knowledge that engineers will need but rather the ability to learn new things quickly and the ability to apply knowledge to new problems and new contexts' *(ABET,2006).* According to Hofstede, the survival of humanity will depend to a large extent on the ability of people who think differently to act together (NAE,2004). Globalization is creating a context in which engineers from one culture need to collaborate and communicate efficiently with professional from other cultures. In this changing context of the engineering profession, the successful engineer will not be the one with only sound knowledge of science and technology, but also can understand cultural issues and has the ability to communicate and collaborate across the cultures Collaboration and Communication in intercultural environment are among some of the most needed professional competencies for engineering students. Globalization, Internationalization, ICT and interactions among different nations have put marked on the importance of intercultural competence and put pressure on engineering educational institutions to focus on it. On the other hand we can see the phenomenon of study abroad by student had increased and is increasing day by day (OECD,2010).

1.1.1. Intercultural Learning in international study programs

The ability to communicate in intercultural setting is considered as an important factor in international study programs and educational manger across the educational institutions are viewing that development of intercultural communication is one of the major element in the international education programs.(Piage,1993).

Paige's Model of intensity factor in intercultural experience

In the analysis of intercultural experiences, Paige (1993) identifies 10 factors that can lead to psychological stress and deep emotions in education settings particularly and as a result influence the intercultural learning experience: (Piage,1993).

1. Cultural differences. Intercultural experience will be will be with mush psychological stress if the degree of cultural differences is higher among the participants in those settings.
2. Ethnocentrism. Ethnocentrism reflects in different ways, first the ethnocentric person himself and the less accepting attitude of the host for outsider put a stress on the sojourners.
3. Cultural immersion. The more immersed the person is in another culture, the greater the amount of stress.
4. Cultural Isolation. If a person is isolated by geography from members of his own culture, their experiences become more stressful.
5. Language. Persons unable to speak their native language will find those intercultural experiences more stressful and social isolation.
6. Expectations. Unrealistic expectations let down the person psychologically while interacting in intercultural situation
7. Visibility and invisibility. Persons who are physically different from others may become as object of unwanted attention or discrimination, sometimes one's identity is invisible for others can cause a stress in intercultural experiences, like political views, sexual orientation, religions.
8. Power and Control. A person in intercultural situations feels a loss of power and control over the incidents happening as compare to the power he holds in his own cultural setting, Psychological stress is associated with the loss of power.

9. Status. Feelings of the person in an intercultural situation about his status, it may include the feelings that a person is not getting the respect he deserve or unearned recognition.
10. Prior Intercultural Experience. A person with prior intercultural experience will be in the many comfortable situation compared to one without or very little background in intercultural setting will be in much stress.

The factors mentioned by Paige provide an understanding for the program coordinators to facilitating the intercultural learning experiences in international study programs.

3. Internationalization of Engineering Education

There is broad recognition that engineering education needs to change in order to meet the challenges of the knowledge society (UNESCO,2010). We are living in a changing society where events and innovations in engineering along with expectations of stakeholders involved have resulted in the globalization of engineering. Wulf reported several trends, which he feels characterize the globalization of engineering. Among them we notice: a vast array of new materials and processes, use of information technology, a need to have both specific technical knowledge and breadth of knowledge, a need for teamwork, and a rapid pace of change calling for lifelong learning (Wulf,1997).

The 21st-Century Engineer, A Proposal for Engineering Reform' cited in Parkinson, (Parkinson, 2007) addresses in detail the globalization issue in engineering. It states: 'A solid understanding of globalization is key to an engineer's success in today's global society. Globalization involves the ability to understand that the world economy has become tightly linked with much of the change triggered by technology; to understand other cultures, especially the societal elements of these cultures; to work effectively in multinational teams; to communicate effectively—both orally and in writing—in the international business language of English; to recognize and understand issues of sustainability; to understand the importance of transparency while working with local populations; and to understand public policy issues around the world and in the country in which one is working. It will be these fundamental capacities that will enable 21st-century engineers to develop into professionals capable of working successfully both domestically and globally, highly respected by the general public and regarded all over the world as professionals of the highest order'(Parkinson, 2007).

4. Project Based Learning

Problem based learning concept is an innovative learning methodology which is considered to be started from the McMaster University in Canada almost five decades ago. Initially it was used in the medical colleges. Problem and project based learning (PBL) is an educational strategy. An approach to organize the learning process in such a manner that the students are actively engaged in finding answers by themselves (Graaff, & Kolmos, 2007) In PBL, students work in collaborative groups to identify what they need to learn in order to solve a problem. The teacher acts to facilitate the learning process unlike a traditional teacher. The success of PBL is illustrated by the fact that since last couple of decades, this method has been introduced in many universities all over the different parts of the world. PBL is practiced in different ways in different parts of the world with different names. (Savin-Baden,2004)
It has different models like Savin-Baden (2000) concludes five models as: PBL for Epistemological Competence, PBL for Professional Action, PBL for Interdisciplinary Understanding, PBL for Trans-disciplinary Learning and PBL for Critical Contestability. (Savin-Baden,2004).

According to Hmelo-Silve the goals of PBL include helping students develop 1) flexible knowledge, 2) effective problem-solving skills, 3) self-directed learning skills, 4) effective collaboration skills, 5) intrinsic motivation (Hmelo-Silver, 2004) There are many research studies conducted to check the effectiveness of PBL also compared with other teaching methodologies. Recently Johannes Strobel and Angela van Barneveld (2009) employed a meta-synthesis method exploring the effectiveness of PBL is regarding of four categories: 1) non-performance, non-skill-oriented, non-knowledge-based assessment, 2) knowledge assessment, 3) performance of skill-based assessment, 4) mixed knowledge and skill-based assessment. They found that students and staff indicated greater satisfaction with the PBL approach to learning.

Dochy (2003) reviewed studies conducted in the 90s on PBL and his main conclusion is that the use of PBL has an impact on improvement of skills development such as process competencies or skills. The impact of knowledge acquisition is missing or not significant. . Also, according to Du (2006) PBL students do not acquire less knowledge compared to traditional educated students.

De Graaff and Kolmos (2003), formulated three common approaches which characterize PBL:1) learning approach is organized around problem, context and the experience of the students. 2) Content approach. 3) Social approach suggests that a majority of learning takes place in the group. So according to this approach learning, is social act where student not only learn from each other but also they also develop the collaborative learning.

In the context of Aalborg University the PBL learning principle is on problem-based project work. In this environment students spend more than half of the time in the groups and teams.
There is pressure on the universities to provide such a learning environment which does not only equip the students with the knowledge of their respective disciplines but also enhances their process competencies and prepares them for future challenges.

PBL provides an interactive learning environment in which group of students work together in the form of a team to achieve certain results of their relevant projects. In this whole process of one semester, they interact, collaborate, and discuss a lot. At the end of the semester, students are expected to achieve certain learning outcomes, which may include professional competencies such as communication and collaboration across cultures.
Aalborg University, which is known for the Problem and Project Based Learning (PBL) in engineering education, is in the context of this paper. This Aalborg PBL model is characterized for its group work.

5. Research Methodology

The scenario mention in the introduction part of this paper is not just an imaginary setting; rather it emerged through am organized data collection methodology, which is based on the qualitative paradigm of research design.
This paper is a part of a PhD project, for which a qualitative approach is utilized to understand the learning experiences of students with different background in a project based learning environment where much focus is on collaboration and communication..

As the objective of this study was to understand learning experiences of international student in the project based learning environment at Aalborg University. Much of the focus was on what happen when international students have to work in groups. How does international student develop and what factors are contributing in the learning process of students Since the objective of this paper was to explore, describe and interpret the transformative learning experiences of international engineering student in groups work specifically at Aalborg University, looking at the objectives and research question a qualitative approach was adapted to study international student.
To achieve the maximum benefits of qualitative methods the research process is extremely important; the research process involves planning of data collection, gaining access to participants, developing rapport.(Cresswell, 2008). The faculty of Engineering and Science at Aalborg University Denmark was selected as a site for conducting this research project. All students enrolled in this university have to work in project groups, in each semester as a part of their study program. Students are provided with group rooms. For this study Master level students were selected as an international students mainly get enrolled at this level. We have made some initial selection conditions for the selection of the student groups. The foremost condition was that there must be at least one international student in the project groups and each of the students must have an experience of at least one semester already at Aalborg University. In selecting the group, a detailed procedure was followed, which was conducting initial meetings with program coordinators. They were told about the research objectives and on their recommendations student groups were contacted. After the willingness of student groups, the observations of the student groups were started. We were able to select nine intercultural student groups. The more details of the students are in a table. 1.

Table 1. Composition of the student groups under observations

Group No	Nationality	M	F	Total	Group No	Nationality	M	F	Total
1	China	0	1	5	5	Romania	0	1	5
	Poland	0	2			Denmark	0	2	
	Germany	0	1			Germany	0	1	
	Bangladesh	0	1			Bulgaria	0	1	
2	Romania	0	1	5	6	Denmark	0	2	5
	Indonesia	0	1			Kenya	1	0	
	Germany	0	2			Czech	0	1	
	Denmark	1	0			Germany	0	1	
3	Denmark	2	0	5	7	Romania	2	0	5
	France	1	0			China	2	0	
	Romania	1	1			Nepal	1	0	
4	Denmark	3	2	7	8	India	1	0	3
	Spain	0	1			France	1	0	
	Italy	0	1			Romania	0	1	
5	Denmark	3	0	6					
	Australia	1	1						
	Germany	1	0						

6. Findings and Discussion

Data was collected by observing nine intercultural student groups, which includes 46 students from 17 different nationalities. Qualitative in-depth interviews (20) were conducted. Each student shared some of 'good' or 'bad' experiences due to the cultural differences in Project Based Learning Environment. Sense making of the students regarding good and bad experience were cluster around the themes of self-adequacy and others inadequacies.
In an effort to understand the influence of cultural differences in intercultural student group in the context of PBL learning environment in engineering education, this study explored those issues and challenges that students face in their group work during different collaborative tasks. Based on continuous observations and collecting viewpoints of the students by conducting interviews. The initial analysis suggests there are a few factors that influence the communication and collaboration in the intercultural student groups significantly:

6.1. *Motivation for Project Group*

In such an intercultural student group, each student is enrolled in this study programme with different expectations. That can be seen in the above mentioned picture.

6.2 *Expectations*

As the group members have different cultural backgrounds and varying prior learning experiences. They have different priorities during the group work, while the other group's members expect different contributions. The expectation of the supervisor is different than the way student work emerged during collaboration

6.*2 Dealing with Cultural differences*

One of the biggest challenges international students face in group work is to interact with students of different cultural backgrounds, many times mis-communication and negative perception emerged due to lack of information and the way of interaction due to different cultural backgrounds. We can sense this from the above mentioned example of the student experience. The problems of interaction with other students create anxiety for that student and it also influenced on the overall group learning process. On the other hand, students reported that their understanding about different cultures have improved due to group work experiences.

6.3*. Rules and regulations for Group work*

Students in intercultural groups show different behaviors towards the group's rules. Some took them seriously and act according to that, while for others they were just some written words.

6.*4 Peer Support*

There are two different perceptions present in the students and also in the literature. First one is that international student does not "speak" with other students. The other perception is that the local student does not want to mix and interact with international students. It was observed and reported by the students that there were communication problems among students with different cultural backgrounds. As coordinators mainly do not force the students in a group against his/her will. It was the mainly student select their own group. So he or she was trying to make a group with his own country fellow student or student sharing similar culture. Examples were for instance the Chinese students were trying to remain in a group. South Asian tried to make a group among themselves while East European students also had their own groups. While same was the case of local students. Local Danish student mainly interacted with themselves and very rarely make groups with the international students. They reported different reasons for not making groups with international students. One of the big reasons, other than the cultural differences, they feel that the international students 'Lack' the experience of working in groups. As a result, they can spoil the group work. They have to work a lot to teach international students about how to work in project groups, so they will not be able to focus on the main project objectives.

7. Conclusion

Culture has a significant influence on the collaborative activities during the group work in an intercultural environment. It is challenging (time management, group dynamics) to learn in intercultural student groups but it is also rewarding (in terms of intercultural learning, employability). These challenges and rewards must be taken into consideration when designing activities for international students and forming the intercultural student groups. It was concluded that the nature of the problem faced by student groups (either intercultural or homogeneous groups) are similar to some extent like coordination of tasks, negotiations, deadlines, time and conflict management, decision making, agreement on group rules in both home student groups and intercultural groups but intercultural differences were adding extra layer of complexity to these issues. There is need to understand this layer of complexity. This paper also contributes to the discussion on cultural issues in group work at international universities.

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References

OOECD, "Education at a Glance 2012: OECD Indicators", OECD Publishing,2012.http://dx.doi.org/10.1787/eag-2012-en

ABET, Inc., Criteria for Accrediting Engineering Programs, 2006, available from http://abet.org/forms.shtml.

National Academy of Engineering , "The Engineer of 2020: Visions of Engineering in the New Century", National Academies Press,2004.

Paige, 1993 in Deardorff, D. (ed.). "The Sage Handbook Of Intercultural Competence" .London: Sage,2009.

UNESCO. (2010). Engineering: Issues, challenges and opportunities for development, Paris: United Nations Educational, Scientific and Cultural Organization

Wulf, W.(1997), Changing nature of engineering. Bridge, 27(2) Available online at: http://www.nae.edu/Publications/Bridge/TheChangingNatureofEngineering/ChangingNatureofEngineering.aspx (accessed 19 september 2012

Parkinson, A(2009), The rationale for developing global competence. Online Journal of Global Engineering Education, 4, 2, 1-15

Graaff, E. de & Kolmos, A, "Characteristics of Problem-Based Learning", International Journal of Engineering Education. 19 (5), 657-662,2003.

Savin-Baden, M., and C.H. Major, "Foundations of Problem-Based Leaming", Maidenhead, Berkshire, England: Open University Press, 2004.

Hmelo-Silver Cindy E, " Problem-Based Learning: What and How Do Students Learn?" Education Psychology Review, Vol.16, No.3, 235-266 ,2004.

Johannes Strobel &Angela van Barneveld," When is PBL more effective? A Meta-synthesis of Meta-analyses comparing PBL to conventional classrooms", The Interdisciplinary Journal of Problem-based Learning, Volume 3, Number1, 44-58, 2009

Dochy, F., Segers, M., Van den Bossche, P., and Gijbels, D., "Effects of Problem-Based Learning: A Meta-Analysis," Learning and Instruction, Vol. 13, pp. 533–568,2003.

Xiangyun, Du (2006). Bring New Values into Engineering Education-Gender and Learning in a PBL Environment. Aalborg: Aalborg University

Creswell, J. W, " Qualitative inquiry and research design: Choosing among five approaches" (2nd ed.). Thousand Oaks,CA: Sage, 2008.

Problem-Based Learning as a Teaching tool in Legal Education: An Islamic Perspective

Nor Asiah Mohamad* (1),

[a]Senior Lecturer,
Civil Law Department, Ahmad Ibrahim Kulliyyah of Laws, International Islamic University Malaysia,
53100, Kuala Lumpur, Malaysiay

Abstract

Problem-based learning has been used as a teaching tool in various teaching and Malaysian learning institutions at various levels; primary, secondary and tertiary. Some institutions emphasise on producing well-rounded graduates who are professionally qualified as well as practicing Islamic values. Problem-based learning as promoted in law teaching involves study of real case problems with special emphasis on the elements of analytical and critical thinking skill, leadership skill, team work, time and file management, reflective journal and peer evaluation. Central in this practice are the elements of integrity, tolerance, trust, brotherhood as well as faith and God-fearing. Apart from describing self-experience and observation, the methods approached in this study is qualitative content analysis where the common features of PBL are analysed from Islamic perspective based on the Quranic verses, hadith, practice of the companions as well as the Muslim jurists.. It is shown in this paper that these features are matters of substance in Islamic education system.

Keywords: Problem based learning, Islamic education, well-rounded graduates, reflective journal, teamwork, critical thinking and problem solving;

1. Introduction

The increasing demands and expectation on quality graduates coupled with various skills from law graduates have put law schools under considerable pressure to redesign their curricula and central aspects of their programs accordingly in order to achieve a right balance between theory and practice. Andrew Scott, the advocate of problem-based learning (PBL) in law, believes that PBL can be used in a number of disciplines as a way of engaging students in 'real' problems. PBL starts with a problem and requires the student to do research, analysis and the application of fact and theory to solve a particular legal problem. (Scott 2004). In law schools, the lectures focus on the conceptual understanding of the topic, relevant provisions, case-studies, application of the law, analysis and conclusion. Tutorials are designed to supplement the lectures where students and lecturers have the opportunity to discuss and apply the substantives and procedures on laws taught earlier. Within the limited time, the tutorial system should be designed to provide avenues for students to acquire soft and hard skills discuss and develop their argumentative and analytical skills. In tutorials, students may work independently or in a team to discuss underlying theory, legal provisions, applicable legal rules, and case law depending on the work pre-assigned by the lecturers or tutor. Lectures are delivered in face to face manner or ICT presentation may be used as a device. In tutorials, 'problem' and the application of laws in the problems are the common tools of learning, with PBL or others. The problem may represent a real case or hypothetical case and its subject matter is organised around several curriculum areas. The multi-disciplinary problem creates curiosity and initiates practice-oriented learning among the students. These types of problems represent a rich learning resource for the students who are challenged to tackle with the following tasks:

a. Know the problem
b. Understand the problem
c. Brainstorming
d. Creating key information lists
e. Identifying and extract issues – primary and secondary
f. Mind mapping by applying thinking skills
g. Searching the references
h. Applying all findings to the problem
i. Analysis
j. Resolving the problem.

There are several learning approaches and processes involved mainly a student-centred enquiry process in which students learn how to be responsible and independent learners and how to develop creative and analytical thinking skills. In PBL, students work within a small learning group of four to five students thus it helps developing interpersonal and group skills, cooperation, tolerance, discipline and enhance communication skills. Lecturers act as facilitators to guide the students and continuously

* Nor Asiah Mohamad : +6-019-3404485
E-mail address: nasiahm@iium.edu.my or nasiahmohd@gmail.com

monitor the students' participation and involvement. In the process, students are required to apply and practise professional skills in addressing a problem, answers are to be made in writing and by oral presentations either in the form of client-counselling, in-house advise, mooting, power point presentation, debate, legal sketch and client counselling. The students need to submit reflective journal, peer assessment form as well as file for submission using a legal firm format. As a facilitator, lecturers guide the students by suggesting appropriate materials and put queries to their proposal while the students actively explore, learn and grow in teams. Students learn how to become independent learners and problem solvers. The learning progress they undergo in solving the problem is more important than the end result.

2. Islam and Problem-based Learning (PBL)

The above described process of learning is not alien in Islamic education. The first word that was revealed to Prophet Muhammad (p.b.u.h.) was "Read." (Al A'laq: 1-5). 'to read and memorize' or 'to read, think, analyse, select, understand and apply?*' Iqra'* is a core mode of acquiring knowledge and is generally believed that knowledge comes before faith (*iman*). The verse reads as follows:

- Read in the name of your Lord who created
- Created man from clots of blood
- Read, your Lord is the most Bounteous
- Who has taught the use of pen
- Has taught man what he did not know (*Surah Al-'Alaq* : 1-5)

There are numerous instances in the *Quran* and the *Sunnah* of Prophet Muhammad (p.b.u.h.) which show that Islam requires Muslim to read with analytical thinking while reciting the Holy Book. A proper reading of al Qur an needs an understanding of the cause of revelation and thus apply it accordingly. Muslims are the leaders in his own cause in this world and also trustees and thus are accountable for his actions. Lead, cooperate, think and work as a team are what is expected throughout the PBL process and students become independent and not a spoon-fed student.

3. PBL organisational framework

In law school, student's ability to resolve issues in problems is always used as a basis to assess their ability to become future lawyers. This ability is not only demonstrated in writing, more importantly, in oral presentation. Presentation is a key criterion in PBL. Leadership is crucial so that the organisational structure of the team works well. It follows Prophet Muhammad's (p.b.u.h.) leadership paradigm.[2] Within the framework of this leadership paradigm, there exists a pragmatic set of workable guidelines for Problem-based Learning students to which they are expected to abide.[3]

The framework of action is a combination of three elements: alignment, attainment and empowerment. Fusion of all three shall produce synergy. Alignment refers to *tawheed;* the vision of the greatness and oneness of God and the mission to commit to the message of God.[4] In Problem-based learning the element of integrity, honesty and accountability are developed with the feeling God-consciousness not merely for the sake of assessment of trust of team members or facilitators. The spirit of God fearing and God-awareness should sustain in oneself and crucial in nation development. Attainment is reflected in the sense of *'ibadah* (worship) by doing good and forbidding evil. It involves total commitment, trust, honesty, support, mutual respect and courage to work in a team.[5] Attainment is the *esprit d'corps*.[6] PBL fosters the spirit of teamwork, with everyone contributing towards the objective. In Islam, everything should be done in this spirit of shared responsibility and togetherness (*jama'ah*), in all aspects. Empowerment is the trust conveyed to man as *khalifah* in this world (vicegerent).[7] Prophet Muhammad (p.b.u.h.) stated that everyone is entrusted by God to be *khalifah*.

"Everyone of you is a shepherd and everyone is responsible for what he is shepherd of." [8]

In the context of PBL, empowerment is to let students to acquire skills and have them use their skills effectively. Synergy (*falah*) is the outcome of PBL. The team's energies are combined and produce a greater achievement than individual efforts.[9]

[2] Ismail Noor, *Prophet Muhammad's Leadership: The Paragon of Excellence Altruistic Management*, Kuala Lumpur, Utusan Publications, 1999, p. 2.
[3] Ibid.
[4] Id., p. 3
[5] Id.
[6] Id., p. 23.
[7] Id.
[8] Sahih Al-Bukhari and Muslim.
[9] Id., p. 24.

Islam promotes consultation in decision making and thus, every member must consult each other (*shurah*). It ensures equal participation and fairness in the problem-solving and decision-making process.[10]

When Prophet Muhammad (p.b.u.h.) allowed his followers to be actively involved in problem-solving and decision-making, he ensured a heightened sense of shared commitment and responsibility for any action the group under his leadership had decided upon. It also created a high level of trust and provided them with the *raison d'etre* for the continuing of an operation with speed and efficiency. Every member felt accountable for its ultimate success.[11]

4. Reflective Journal Writing and PBL

Reflective writing in the form of journal writing has become a popular educational tool, especially in the field of Problem-based Learning. It is considered an excellent way for a facilitator to assess his/her students' learning progress. There is a general agreement on what a student's reflective journal should contain, namely:

- summary of learning activities and topics
- observations of learning experience, incidents or events
- analysis of incidents and developments
- progress reports of PBL presentations
- understanding and perception of the learning process

A proper reflective journal should contain matters which are beyond immediate reporting and should address the student's personal observations.

In PBL, writing a reflective journal is a compulsory requirement and is part of the assessment criteria. Reflective journal writing trains the students to be self-disciplined, self-critical and objective as well as honest with them. The writing process includes various stages. Entries have to be made frequently and consistently so that the recorded events are still fresh in the students' minds. It should reflect accuracy and a proper understanding of relevant detail to ensure a complete record of what has been taught and learned. Besides, the reflective journal should also contain implications for future learning to ensure that all processes have been addressed correctly, honestly and vividly.

Students may use reflective journal as a means of critical self-assessment which helps to assess their achievements to fulfil the learning objectives. Reflection warrants a special attention particularly if the result of objectives do not show improvement. Reflective journal mirrors the level of proficiency and knowledge of a student and help identify his/her areas of interest. In legal education, file management provide a good form of reflective journal where all updates must be consistently performed and checked. Reflective Journal may include that of:

- A diary: Throughout school and university students are mostly passive learners. Keeping a reflective journal is in essence similar to having dialogue with one's self.
- A record of assessment: It is a compilation of the assessment for the subject or assignment that a student undertakes
- Thinking tool: It helps the student to develop an individual and effective way of thinking.
- Progress report: The entries reflect how much effort a student has put in to resolve a particular problem, and also show the duration of time the student needed.

5. Reflective Journal and *Muhasabah* (reflection) in Islam

God is All-Seeing, All-Hearing and All-Knowing.[12] Being aware of that instills in students the right mentality to prepare them for their future responsibilities. PBL teaches the students to develop teamwork, working towards fulfilling the team's target rather than for personal gain or interest, and fulfilling one's responsibility and expectation from other members of the group.

It is reported that Prophet Muhammad (p.b.u.h.) said: "The hand of Allah is with the *jama'ah* (team or congregation). Then, whoever singles himself out (from the j*ama'ah*) will be singled out for the Hell-fire.[13]

Journal writing trains the students to be sincere, share information and act in an open and transparent manner. By use of the record, a student is able to assess him/herself, learn from his/her mistakes and develop a better strategy for the future. This process of continuous self-assessment and reflection (*muhasabah*) is spiritual practice and expected from every conscious Muslim. It is reported that Prophet Muhammad (p.b.u.h.) said: "He whose two days are equal (in accomplishment) is a sure

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[10] Ibid.
[11] Id., p. 25
[12] *Surah* 49:2
[13] Reported in *Sunan al-Tarmidhi*

loser."[14] This *hadith* stresses the vital importance of self-improvement, and there can be no improvement without prior reflection and assessment. A reflective journal should not only serve as an instructional tool but as an invitation to serious self-commitment. A Muslim or any other God-fearing individual is certain that his actions are witnessed and judged by God. The objectives, whether successfully put into practice or otherwise, carry a reward from God:

"Not a single dawn breaks out without two angels calling out: "Oh son of Adam, I am a new day and I witness your actions, so make the best out of me because I will never come back till the Day of Judgment."[15]

Furthermore, in Islam it is considered praiseworthy to share knowledge, advise others and trust others, as Prophet Muhammad (p.b.u.h.) meant when he said "Religion is sincere advice". Reflective journal writing thus serves spiritual as well as practical purposes in learning and teaching.

Reflective journal writing helps the students to manage their time effectively. In the Qur'an the passage of time is again and again emphasized, and those who ignore the importance of time shall fail.[16] The importance of reflective journal could also be seen in *Surah al-Baqarah* 282-283. Although these verses concentrate on the record of contracts and transactions, the benefits of a proper record no doubt encompass all matters dealing with more than two people.

PBL involves group work and record of all activities and events thus; encourage more efficiency and better outcomes. Reflective journal is not only an individual record of one's own progress and assessments, but also something which requires group participation. The record keeps track of each participant's roles and duties.

6. Teamwork in Islam

In a team, there are two main elements that become a matter of substance in Islam. Firstly, a team which is normally referred as *'jamaah'* (congregation) and leadership. Working as a team and choose a leader to lead the team is compulsory in Islam and it is an act of submission ('*ibadah*) to God.[17] The term 'teamwork' is defined as "the ability to work together toward a common goal" and "to direct individual accomplishment towards organizational or institutional objectives".[18] A team comprises of people working together, trusting one another, complementing each other's strengths and compensating each other's limitations.[19] Groups are collections of individuals that are gathered together to work to achieve certain common objectives. The reference to the term 'team' with this connotation can be found in numerous verses of the Holy Quran. For instance in *Surah al-Imran* (5): 104:

"Let there arise among you a group that invite others to good work, enjoining what is right and forbidding what is wrong. They shall indeed be granted success."

"Faithful believer are to each other as the bricks of a wall, supporting and reinforcing wach other. So saying, the Prophet (p.b.u.h.) clasped his hands by interlocking his fingers. (Vol 1, Sahih Al Bukhari)[20]

According to Islam the best way to succeed and lead any institution towards excellence is to work in '*jama'ah*' (as a team). *Surah Al-Imran* states to this effect:

"And hold fast, all of you together, to the rope of Allah, and be not divided among yourselves, and remember Allah's favor on you, for you were enemies one to another but He joined your hearts together, so that, by His Grace, you became brethren (in faith); and you were on the brink of a pit of fire, and He saved you from it. Thus Allah (swt) makes His signs clear to you, that you may be guided".[21].

Prophet Muhammad (p.b.u.h.) is reported to have said: "The hand of Allah is with the community (*jama'ah*)". Abu Hurayrah (r.a.) reported: "I have not seen anyone to be more diligent in consulting the companions than the Prophet (p.b.u.h.) himself". In another *hadith*, the Prophet (p.b.u.h.) is reported to have told Abu Bakr and 'Umar (r.a) that if they both agreed upon a council, he would not oppose it. In fact, on a number of occasions, the Prophet (p.b.u.h.) consulted his companions on private and public

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[14] *Sunan al-Daylami*
[15] *Al-Ma'thur* of the Prophet (p.b.u.h.)
[16] *Sunan al-Daylami*
[17] Abu Daud 2:827, Chapter 1089, Hadith No. 2922.
[18] Mohammad Naqib Ishan Jan, "Teamwork Towards Excellance", paper presented on the Principal and Fellow Induction Course 2003, International Islamic University Malaysia, May 2003.
[19] Ismail Noor, *Prophet Muhammad's Leadership: The Paragon of Excellence Altruistic Management*, p. 51.
[20] http://ebooks.worldofislam.info/ebooks/Hadith%20&%20Sunnah/Sahih%20Al-Bukhari%20Volume%201.pdf, seen on 17th March 2013.
[21] *Al-Imran*, 3:103.

affairs, and at times he gave preference to their opinions over his own views. All members of a team must cooperate in pursuance of virtue and beneficence, and not of hostility and transgression. "Cooperate with one another in the pursuit of virtue and beneficence, but cooperate not in fostering hostility and transgression."[22] As a Muslim, to act upon the teaching of the Prophet (p.b.u.h.) is part of an act of submission to God. Teamwork is developed through a sound and healthy relationship based on covenantal understanding through sincere feelings, trust in one another, intimacy or brotherhood as required by Islam. In Islam there is a golden rule to the effect: "No one of you is a believer until he desires for his brother that which he desires for himself." The key to success is sincerity which can only be nurtured if one is sincere to oneself and God. It is a very tall order to develop sincerity in a spiritual vacuum. Love for Allah (swt) promotes the development of good intentions and practices in human behavior. Without the spiritual dimension, it is nearly impossible to build up and retain a high level of team spirit in an organization or institution.

Every member of the team is accountable for his/her assigned task, and every member of the team is responsible for his/her own performance level. "Every person is accountable for what he earns, for no bearer of a burden bears the burden of another."[23] Prophet Muhammad (p.b.u.h.) is reported to have said in this respect "I am accountable for my actions and you are for yours."[24]

In an Islamic institution, PBL should fall within its mission and philosophy, knowledge towards propagating the spirit of faith and the recognition of Allah (swt) which represents the apex in the hierarchy of knowledge. Knowledge is understood as a form of divine trust *(amanah)* to mankind, and hence mankind must utilize knowledge according to His will. Seeking and propagating knowledge is regarded an act of worship. All Islamic institutions aim at producing a distinctive class of intellectuals, professionals and scholars by integrating the qualities of faith (*iman*), knowledge (*`ilm*), and good character (*akhlaq)* to serve as agents of a comprehensive and sustainable progress and development in the Muslim world. PBL complements this aim by instilling a heightened sense of commitment for life-long learning and social responsibility among the staff and students.

The main obstacle to the full implementation of PBL in legal institution is to challenge the assumption that law has always been taught using a problem-based methodology. After all, law is about legal problems, real or hypothetical. Although PBL is considered a more creative and effective way of teaching, the argument against it is that law lecturers and students are already overloaded following the standard curriculum. PBL may add to the existing workload but the benefit the students gain by being exposed to an alternative method of learning is worth the extra energy and time invested into it.

7. Conclusion

PBL requires serious form of commitment from lecturers and students alike. In legal eudcation, students are given the opportunity to actively explore issues, learn to resolve problems and work in teams. PBL is relevant for client based industry as it helps develop student's maturity, honesty and integrity which form the basic values in legal profession. PBL method is not new in Islamic education in general and law teaching and training in particular. Law teaching and learning focus on certain processes which emphasise on ethics and values and provide a means of critical self-assessment of individual capacities and performance levels for each member of a working team. In addition to grooming professional, PBL plays essential role in raising the level of commitment to religious and moral values.

References

The Qur'an (1410H) (translation) King Fahd Holy Qur'an Printing Complex.

Bailey,S. (2004). *Using problem-based learning to teach company law*, http://www.ukcle.ac.uk/pbl/solent.html March 16th 2004

Generic Problem-Based Learning Essentials, http://www.pbli.org/pbl/generic_pbl.htm

Wachala,K. (u.d) "Changing Perceptions and Needs of legal Education and the Usefulness of Iolis in these Changing Times", http://www.bileta.ac.uk/01papers/wachala.html

Richard Mullender,*R.* (1997) *Law, Undergraduates and the Tutorial*. 3 Web JCLI

Scott,A. (2003). *Problem-Based Learning (PBL) in Law*, http://www.ukcle.ac.uk/pbl/index.html Jun 9th 2003.

Scott,A. (2003). *Problem-Based Learning (PBL) working group* http://www.ukcle.ac.uk/pbl/message.html Jun 9th 2003

Scott, A. (2010) "Problem-based learning in Law". http://www.ukcle.ac.uk/resources/teaching-and-learning-practices/pbl/retrived 16th March 2013.

Grimes,R. (2003) . "Learning through problem-solving in a real client context*"*. (College of Law). http://www.ukcle.ac.uk/events/grimes.html Jun 9th 2003

UK Centre Legal Education, "Using problem-based learning in law", http://www.ukcle.ac.uk/events/pbl.html Jun 9th 2003

Nik Azis Nik Pa. (2004). "Radical Constructivism And Problem-Based Learning: Alignment Between Theoretical Principles and Instructional Practices", paper presented at 5Th Asia-Pacific Conference on Problem-Based Learning: Pursuit of Excellence in Education, March 16-17, 2004

Glen O' Grady, O Glen. (2004). *The dangers of PBL (and other instructional fads): Beware the epistemological hole in the practice of PBL*, paper presented at 5Th Asia-Pacific Conference on Problem-Based Learning: Pursuit of Excellence in Education, March 16-17, 2004

Chang, C.T. (2004). "Problem-Based Learning: UNIMAS Nursing Programme Experience*"*, http://nt.media.hku.hk/pbl/book/Malaysia3_ChangC.pdf , March 2004

UK Centre Legal Education (2004) "Using problem-based learning in legal education*"*, http://www.ukcle.ac.uk/events/pbl.html April 8th .

UK Centre Legal Education "Using problem-based learning to teach constitutional and administrative law", http://www.ukcle.ac.uk/pbl/uea(2004). 2.html. April 8th."

Barbara J. Dutch (2004). Problem-Based Learning", http://www.udel.edu/pbl/cte/spr96-edit.html January 9th .

Linda Dion. (2004). But I teach a Large Class…, http://www.udel.edu/pbl/cte/spr96-bisc2.html January 9th

[22] *Surah Al-Maidah* (5) : 2.
[23] *Surah al-An'am* (6) : 164.
[24] *Sahih* al-Bukhari and Muslim.

Deborah E. Allen. "Teaching with Tutors: Can Undergraduate Effectively Guide Student Problem-Based Learning Groups?*"*, http://www.udel.edu/pbl/cte/spr96-bisc.html January 9th.
Elizabeth M. Lieux, "A Comparative Study of Learning vs. Problem-Based Format", http://www.udel.edu/pbl/cte/spr96-nutr.html January 9th 2004
Components of Problem-Based Education 2004). http://www.unimaas.nl/pbl/law/law002.htm January 9th
UK Centre Legal Education. (1998). "Law Discipline Network: report on general transferable skills".
http://www.ukcle.ac.uk/resources/ldn/skills.html March 30th. 2004
Kelley Burton Bus (2004). *Assessing Teamwork Skills in Law School: A Window of Opportunity*, http://www.murdoch.edu.au/elaw/issues/v10n2/burton102_text.html March 30th.
Nancy J. White, "Using Law Class to Teach Problem-Solving and Writing Skills", http://asceditor.unl.edu/archives/1999/white99a.htm March 30th. 2004
"Enquiry Based Learning", http://www.ltsn.ac.uk/genericcentre/index.asp?docid=19593 April 29th 2004
"Problem-based Learning", especially in the context of large classes, http://chemeng.mcmaster.ca/pbl/pbl.htm March 30th. 2004
Donald R. Woods (2004). "Problem-Based Learning: helping your students gain the most from PBL", http://chemeng.mcmaster.ca/pbl/pbl.htm March 30th. 2004
Boud, D and Feletti,G. (Eds.) (1991) *The Challenge of Problem-Based Learning*, London, Kogan Page, 1991.
Schwart, P Mennin, S. and Webb.,G. (Eds.) (2001). *Problem-Based Learning: Case Studies, Experience And Practice*, London, Kogan Page Limited.
Ismail Noor (1999). *Prophet Muhammad's Leadership: The Paragon of Excellence Altruistic Management*, Kuala Lumpur: Utusan Publications.
Bashiran Begum (2004) "Implementing Problem-Based Learning in AIKOL, IIUM: A Paradigm Shift?" Paper presented in Workshop on Problem-Based Learning, AIKOL, June 4th .
Bashiran Begum. (2004)."The role of facilitators and students in problem-based learning" Paper presented in Annual Problem-Based Learning Workshop, Using Problem-Based Learning to Enhance Teaching Skills in AIKOL, December 24th 2004.
Bashiran Begum and Sharifah Zubaidah, (2005)."Implementing PBL in AIKOL, IIUM: A Paradigm Shift?**"** Paper presented at the International Conference on Problem-Based Learning, Lahti, Finland, 9-11 June.
Bashiran Begum and Sharifah Zubaidah, (2005). **"**PBL: Impact on Communication Skills for Law Students*"*, PBL in Context – Bridging Work and Education International Conference on Problem-Based Learning, 9-11 June Lahti, Finland
Nor Asiah Mohamad and Bashiran Begum (2004). "The Implementation of Problem Based Learning At AIKOL*"*, PBL Conference 2004 : Cancun, Mexico, 13-19 June.
Nor Asiah Mohamad (2004). "Reflective Journal for PBL in IIUM: The way forward". Workshop on Problem Based Learning, AIKOL, International Islamic University, Malaysia, December 24th.
Nor Asiah Mohamad (2006). "Problem Based Learning: Arduous Yet Effective Method of Teaching Law*"*, Students Development National Conference, Grand Season Hotel, Kuala Lumpur, 7-9th August.
http://www.pbl.cqu.edu.au/content/what_is_pbl.htm August 7th 2003