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Design, Implementation, and Evaluation

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Problem Based Learning (PBL) for Malaysia Teacher Education: Design, Implementation, and Evaluation

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v. Borhan, M.T., Yassin, S. M. (2014). Impact of Problem Based Learning (PBL) Implementation on Student Learning. *Australian Journal of Teacher Education* (under review).

The thesis is based on the submitted or published scientific articles which are listed above. The results presented in the articles are included in the first part of the thesis. For the assessment, co-author statements have been made available to the assessment committee and are also available at the Faculty. The thesis is not in its form acceptable for open publication yet.

SUMMARY

This research involved developing, implementing and evaluating Problem Based Learning (PBL) designs in the context of Malaysian teacher education. As a relatively new teaching and learning approach in the Malaysian higher education landscape, the student-centered learning such as the PBL has posed challenges since the approach was too different from the demands and constraints of contextual needs, i.e Malaysian teacher education. With regards to this challenge, the proposed PBL designs have been adjusted to suit the Malaysian teacher education.

Putting forward the above issues, the researcher has adopted Design Based Research (DBR) as the research methodology due to its principles that strive to make learning research more contextually relevant. In particular, the method addresses the needs and norms of a local context, which has led to research findings that are scientifically trustworthy and useful in practical sense.

DBR emphasises synergistic relationship between researching, designing and engineering the PBL design in an effort to understand learning in a complex environment. Since the method concerns learning and cognition, its inherent activities of research and design involve (1) collaborating with local practitioners, (2) developing and implementing the PBL design, (3) striving to refine and improve the PBL design through iteration and adjustment and (4) seeking to document the impact of the PBL design implementation on students' learning and students´ learning environment. Instead of strictly following a set of ideas, the DBR allows the researcher to systematically adjust and iterate the PBL design as the research progresses especially during the implementation phase. This practice of embedded research within practical activities has led to (1) having the PBL design itself as a study, (2) better informed core issues in education, and (3) achievement of higher external validity.

To achieve such PBL designs, the research was divided into three design phases: *Compiling initial findings for the PBL design*, *Developing the PBL design for Malaysia setting* and *Implementing the PBL design in Malaysia setting*. The first design phase aimed to shed light on the impact of PBL on student learning, and the potentials and

constraints of PBL implementation. Evidence Such information were gathered from theoretical, practical and contextual perspectives. Accordingly, research findings on the impacts of PBL on students' learning were favourable and the key potentials and constraints were identified. These collective initial findings have served as one of the three elements for PBL design development in the second design phase (i.e., *Developing the PBL design for Malaysia setting*). Another two elements involve in this PBL design development phase are; PBL curriculum elements and course analysis. A number of PBL curriculum elements were analysed to ensure that they were aligned, while the intended course for the PBL design implementation was analysed to ensure that the learning outcomes were addressed in the PBL design. Following the results from the second design phase, the course content was transformed into three PBL problems (PBL1: *Constructivism*, PBL2: *Alternative Conception* and PBL3: *21st Century Learning*). Each of these PBL problems emphasise on both knowledge and skills acquisition among the students. The PBL toolkit was also developed for all the PBL problems such as lesson plan, PBL scenario, student written reflection and assessment.

Subsequently, the PBL design was brought into practice in the third design phase (i.e., *Implementing the PBL design in Malaysia setting*). The aim of this phase is to implement the PBL design in Malaysian teacher education context and to ascertain the impact of the PBL design implementation on students´ learning and on students´ learning environment. Different numbers of weeks are required for the students to deal with the three PBL problems. Likewise, each PBL problem has different number of PBL learning cycles for the students to complete. To obtain the empirical data on the impact of the PBL design implementation on students´ learning and students´ learning environment, observation, students´ written reflection, interview and questionnaire were used. Data analysis approach such as inductive analysis and descriptive statistics were use to qualitative and quantitative data respectively.

The findings of this research have indicated that the students were aware of the knowledge and the variety of skills they acquired, developed and improved throughout the course. The PBL activities that required the students to be actively involved in the learning process were linked to the knowledge and skills they acquired. The group learning activities–which included brainstorming, discussing, arguing, presenting and locating resources–have served as an opportunity for them to validate arguments, and

exchange and expand ideas–all of which have resulted in better resolutions of the tasks. The students also remarked their favour towards PBL: they felt comfortable sharing information and asking for help from the other group members. In managing the information, the students pointed out that their ability to find, reach and analyse information has improved, thus, they have learned a lot during the activities.

The above findings have spoken directly about (1) the methodology, (2) the PBL design and (3) the teaching and learning activities and materials. Application of DBR as the research methodology increases the relevance of the PBL design for the Malaysian teacher education since it value and consider multiple elements that influence learning. Therefore, initiating the new learning practice such as PBL is possible in a context that is entrenched with traditional learning practice, i.e Malaysian teacher education. The research has demonstrated that DBR is a feasible means to reconciliate the distance between PBL and the present learning environment adaopted in Malaysian teacher education.

SAMMENDRAG

Denne forskningsrapport omhandler udvikling, implementering og evaluering af Problembaseret Læring (PBL) designs i en malaysisk læreruddannelsessammenhæng. Den studenter-centrerede læring som f.eks. PBL er en relativt ny undervisnings- og læringstilgang på videregående uddannelser i Malaysia og det gav nogle særlige udfordringer, da dens tilgang var for forskellig fra de krav, begrænsninger og behov der er i den malaysiske læreruddannelse og kontekst. Under hensyntagen til denne udfordring er de foreslåede PBL designs justeret til at passe til den malaysiske læreruddannelse.

Under hensyn til ovennævnte forhold har forfatteren valgt Design Based Research (DBR) som metodologi, da principperne bag DBR stræber efter at gøre læring mere kontekstrelevant. Metoden tager højde for behov og normer i en lokal kontekst, hvilket har ført til forskningsresultater, der både er videnskabeligt pålidelige og praktisk anvendelige.

DBR lægger vægt på synergien mellem at forske, designe og konstruere PBL design i et forsøg på at forstå læring i et komplekst miljø. Da metoden vedrører læring og kognition, involverer dets iboende forsknings- og designaktiviteter (1) samarbejde med lokale praktikere (2) udvikling og implementering af et PBL-design (3) forsøg på at forfine og forbedre et PBL-design gennem gentagelse og justering og (4) søge efter at dokumentere den indflydelse implementeringen af et PBL-design har både på de studerendes læring og læringsmiljø. I stedet for stramt at følge et sæt af ideer, giver DBR forskeren mulighed for systematisk at justere og ny gentagelse af PBL-designet efterhånden som forskningen skrider frem. Praksissen med indlejret forskning inden for praktiske aktiviteter har ført til (1) at PBL bliver til et studie i sig selv (2) bedre forståelse af grundlæggende forhold inden for uddannelsessystemet (3) opnåelse af højere ekstern validitet.

For at opnå sådanne PBL designs, blev forskningen opdelt i tre designfaser: *Indsamling af de første resultater til PBL designet, Udvikling af PBL design til en malaysisk sammenhæng* og *Implementering af PBL designet i en malaysisk sammenhæng*. Den første designfase stræbte efter at få indblik i hvilken evidens der er for den indflydelse PBL har på de studerendes læring, samt potentialer og begrænsninger i implementering af

PBL. Evidensen blev indsamlet ud fra teoretiske, praktiske og kontekstuelle perspektiver. Som følge heraf var forskningsresultater om PBLs indvirkning på de studerendes læring nyttige, og de vigtigste potentialer såvel som begrænsninger blev identificeret. Denne samling af første resultater har ligget til grund for ét af de tre elementer i PBL-designets udvikling i den anden designfase (dvs. udvikling af PBL design til en malaysisk ramme). To andre elementer der indgår i denne PBL-designudviklingsfase er: PBL-curriculumfaktorer og kursusanalyse. Et antal PBL curriculumfaktorer blev analyseret for at sikre at de var alignet, mens den planlagte retning for PBL-designet blev analyseret for at sikre, at læringsresultaterne blev adresseret i PBL-designet. Ved at følge resultaterne fra den anden designfase, blev kursuselementerne transformeret til tre PBL problemer (PBL 1: *Konstruktivisme,* PBL2: *Alternativ opfattelse* og PBL 3: *21. århundredes læring).* Derudover blev læringsresultater, der lægger vægt på udvikling af både viden og færdigheder, adresseret, en PBL værktøjskasse, der fungerer som både undervisnings- og læringsmateriale for såvel facilitatorer som studerende, blev udviklet, gruppebedømmelser blev konstrueret og formodninger om læringsprocessen (PBL læringscyklus) blev fremlagt.

Efterfølgende blev PBL designet bragt i anvendelse i den tredje design fase (dvs. implementering af PBL-designet i malaysisk sammenhæng). Formålet med denne fase var at implementere PBL-designet i den malaysiske læreruddannelse og sikre PBL-designets indflydelse på de studerendes læring og deres læringsmiljø. De studerende har forskelligt antal uger til at arbejde med de tre PBL problemer. Ligeledes har hvert PBL-problem et forskelligt antal PBL-læringscyklusser, som de studerende skal gennemføre. For at få empiriske data om, hvordan implementeringen af PBL-designet havde indflydelse på de studerendes læring og deres læringsmiljø, blev der brugt observation, skriftlige refleksioner fra de studerende, interview og spørgeskema. Dataanalyseteknik, så som induktiv analytisk tilgang og deskriptive statistikker blev brugt til såvel kvalitative som kvantitative data.

Resultaterne af forskningen viser, at de studerende var bevidste om den viden og de forskellige færdigheder de havde opnået, udviklet og forbedret gennem kurset. PBL-aktiviteterne, som krævede, at de studerende var aktivt involveret i læringsprocessen, var forbundet med den viden og de færdigheder, de opnåede. Gruppelæringsaktiviteter, som involverede brainstorming, diskussioner, argumentering, præsentation og lokalisering af

resurser, har givet dem en mulighed for at validere argumenter og for at udveksle og udvide deres ideer. Alt dette har resulteret i bedre opgaveløsninger. De studerende gav også udtryk for velvilje over for PBL: de var tilpasse med at dele deres information og bede om hjælp fra andre gruppemedlemmer. I deres behandling af informationen påpegede de studerende, at deres evne til at finde, forstå og analysere information var forbedret, og at de dermed havde lært en masse igennem aktiviteterne.

De ovennævnte resultater har direkte nævnt (1) metodologien (2) PBL-design og (3) undervisnings- og læringsaktiviteter og materialer. Anvendelse af DBR som forskningsmetodologi øger således relevansen af PBL-designet for den malaysiske læreruddannelse.

RUMUSAN

Penyelidikan ini melibatkan pembangunan, perlaksanaan dan penilaian rekabentuk Pembelajaran Berasaskan Masalah (PBM) dalam konteks pendidikan guru Malaysia. Sebagai pendekatan pembelajaran dan pengajaran yang relatifnya baru dalam landskap pendidikan tinggi Malaysia, pembelajaran berpusatkan pelajar seperti PBM telah memberi cabaran kerana pendekatan ini terlalu berbeza daripada kehendak dan kekangan dalam keperluan kontekstual (i.e., pendidikan guru Malaysia). Rentetan dari cabaran ini, rekabentuk PBM yang telah dicadangkan adalah diselaraskan untuk disesuaikan dengan konteks pendidikan guru Malaysia.

Untuk mengetengahkan isu-isu di atas, penyelidik telah menerima pakai Penyelidikan Berasaskan Rekabentuk (PBR) sebagai metodologi kerana prinsipnya yang berusaha untuk membuat penyelidikan pembelajaran yang lebih relevan dalam konteks. Secara khususnya, metod ini mengutarakan keperluan dan norma konteks tempatan, yang telah membawa kepada dapatan penyelidikan yang boleh dipercayai secara saintifik dan berguna dari segi praktikal.

PBR menekankan hubungan sinergi antara penyelidikan, mereka bentuk dan kejuruteraan rekabentuk PBM dalam usaha untuk memahami pembelajaran dalam suasana yang kompleks. Oleh kerana metod mengambil berat tentang pembelajaran dan kognisi , aktiviti yang sedia ada dalam penyelidikan dan reka bentuk melibatkan (1) bekerjasama dengan pengamal tempatan , (2) membangun dan melaksanakan reka bentuk PBM , (3) berusaha untuk memperbaiki dan menambah baik pembangunan PBM melalui iterasi dan penyesuaian dan (4) ingin mendokumentasikan kesan pelaksanaan reka bentuk PBM pada pembelajaran dan persekitaran pembelajaran pelajar. Selain dari mengikuti satu set idea-idea secara ketat, PBR membolehkan penyelidik untuk menyesuaikan PBM secara sistematik dan iterasi reka bentuk PBM semasa progres penyelidikan berlansung. Amalan penyelidikan ini dalam aktiviti praktikal telah membawa kepada (1) pengkajian rekabentuk PBM itu sendiri, (2) memberi maklumat tentang isu akar umbi pendidikan dan (3) pencapaian kesahihan luaran yang lebih tinggi.

Untuk mencapai reka bentuk PBM , kajian ini telah dibahagikan kepada tiga fasa reka bentuk: Mengumpul hasil penyelidikan awal untuk reka bentuk PBM, Membangunkan reka bentuk PBM bagi tetapan dalam Malaysia dan Melaksanakan reka bentuk PBL dalam suasana Malaysia. Fasa reka bentuk pertama bertujuan untuk memberi penerangan mengenai bukti kesan PBM kepada pembelajaran pelajar, dan potensi dan kekangan dalam pelaksanaan PBM . Bukti telah dikumpulkan dari perspektif teori , praktikal dan kontekstual. Oleh itu, hasil penyelidikan terhadap impak PBM kepada pembelajaran pelajar adalah menggalakkan dan potensi utama dan kekangan telah dikenal pasti. Penemuan awal kolektif dijadikan sebagai salah satu daripada tiga unsur pembangunan rekabentuk PBM dalam fasa reka bentuk kedua (i.e, membangunkan reka bentuk PBM bagi tetapan Malaysia). Dua lagi elemen melibatkan dalam fasa pembangunan reka bentuk PBM ini adalah; elemen kurikulum PBM dan analisis kursus. Beberapa elemen kurikulum PBM dianalisis untuk memastikan keselarian, manakala kursus yang dicadangkan untuk pelaksanaan reka bentuk PBM dianalisis bagi memastikan hasil pembelajaran diutarakan dalam reka bentuk PBM ini. Rentetan hasil daripada fasa rekabentuk kedua,kandungan kursus telah ditransformasikan menjadi tiga masalah PBM (PBM1: Konstruktivisme, PBM2: Konsepsi Alternatif dan PBM3: Pembelajaran Abad ke-21). Hasil pembelajaran yang menekankan pengetahuan dan kemahiran pembelajaran telah diutarakan, Kit PBM yang berfungsi sebagai bahan pengajaran dan pembelajaran untuk kedua-dua fasilitator dan pelajar telah dibangunkan, pentaksiran kumpulan telah dibina dan andaian proses pembelajaran (kitaran pembelajaran PBM) telah dibuat.

Selanjutnya, reka bentuk PBM telah dipratikkan dalam fasa reka bentuk ketiga (i.e, melaksanakan reka bentuk PBL dalam suasana Malaysia). Tujuan fasa ini adalah untuk melaksanakan reka bentuk PBM dalam konteks pendidikan guru Malaysia dan menentukan kesan pelaksanaan reka bentuk PBM terhadap pembelajaran dan persekitaran pembelajaran pelajar. Beberapa minggu diperuntukkan kepada pelajar untuk menangani tiga masalah PBM. Dengan itu, setiap masalah PBM juga mempunyai bilangan kitaran pembelajaran PBM yang berbeza kepada pelajar. Untuk mendapatkan data empirikal mengenai kesan pelaksanaan reka bentuk PBL pada pembelajaran dan persekitaran pembelajaran pelajar, kaedah pemerhatian, refleksi pelajar bertulis, temuduga dan soal selidik telah digunakan. Teknik analisis data seperti pendekatan induktif dan analisis statistik deskriptif telah digunakan untuk data kualitatif dan kuantitatif.

Hasil kajian ini telah menunjukkan bahawa pelajar-pelajar menyedari pengetahuan dan kepelbagaian kemahiran yang telah mereka peroleh , membangun dan bertambah baik sepanjang kursus. Aktiviti PBM yang memerlukan pelajar untuk terlibat secara aktif dalam proses pembelajaran telah dikaitkan dengan pengetahuan dan kemahiran yang mereka perolehi. Aktiviti pembelajaran secara berkumpulan melibatkan sumbang saran , perbincangan, berhujah , penyampaian dan pencarian sumber telah digunakan sebagai suatu peluang bagi mereka untuk mengesahkan hujah, dan bertukar dan mengembangkan idea yang kesemuanya telah menjana resolusi yang lebih baik untuk tugasan. Pelajar juga telah menunjukkan kecenderungan terhadap PBM: mereka merasa selesa untuk berkongsi maklumat dan meminta bantuan daripada ahli-ahli kumpulan yang lain. Dalam menguruskan maklumat, pelajar menegaskan bahawa keupayaan mereka untuk mencari, mencapai dan menganalisa maklumat telah menjadi bertambah baik, justeru itu, mereka telah banyak belajar semasa aktiviti dijalankan.

Dapatan kajian di atas secara langsung diperkaitkan dengan (1) metodologi kajian, (2) reka bentuk PBM serta (3) aktiviti dan bahan pengajaran dan pembelajaran. Penggunaan PBR sebagai metodologi penyelidikan telah meningkatkan kesesuaian reka bentuk PBM dalam pendidikan guru Malaysia kerana ianya menilai dan mempertimbangkan pelbagai element yang mempengaruhi pembelaajaran. Maka, memulakan satu amalan pembelajaran yang baru seperti PBM adalah berpotensi walaupun konteks pendidikan guru Malaysia adalah berakar umbikan pembelajaran berpusatkan guru. Penyelidikan ini telah menunjukkan bahawa PBR adalah satu wadah yang berpotensi dalam usaha merapatkan jurang antara amalan pembelajaran semasa pendidikan guru Malaysia dan PBM.

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Mohamad Termizi Borhan
June 2014

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CHAPTER 1

INTRODUCTION

To meet the goal of educating pre-service and in-service school teachers for 21st century schools, teacher educators in higher education are demanded to employ an innovative forms of pedagogy that suits adult learners. Conventional pedagogy that entrenched in higher education is no longer sufficient to meet this current demand. Being at the frontline in preparing Malaysian school teachers, teacher educators continually seek better ways to strengthen their students´ (pre-service and in-service school teachers) knowledge, skills and dispositions in order to be successful in diverse classrooms.

To meet such demand, Problem Based Learning (PBL) is one of the teaching and learning approach designed to foster active learning experience and inculcate skills and competencies among students. Accordingly, this research aims to develop, implement and evaluate a PBL design in the context of Malaysian teacher education. The first section of this chapter provides preliminary insights on the motivation and drivers for the shifting to active learning practice in higher education from policy perspective.

Since active learning is entrenched from constructivism philosophy, the second section comprehensively discusses the many aspects of PBL, from basic assumption of learning to interpreting the practice from constructivism point of view. The third section discusses PBL from models practices in specific institutions and learning principles that derived across variety of PBL models. The fourth section gives an overview of PBL implementation both in Malaysian higher education and in teacher education. Analysis of the interplay between those aforementioned issues, research questions and research objectives are formulated in the fifth part of this chapter.

1.1 Background

Concerns towards education systems that do not adequately prepare students for living and working have prompted reviews in education worldwide. Students' learning in higher

education is largely influenced by the way their teachers/lecturers teach. A long-standing criticism with regards to this issue is the approach of teaching and learning in higher education that disregards students' attainment of skills and competencies. Higher education specialists suggest that institutions should focus on inculcating generic skills (Murray-Harvey et al., 2004) and emphasize on the quality of the thinking process rather than accuracy of the students´ answers (Casey and Howson, 1993).

In the past, extensive cognitive science studies on the nature of learning have focused on having teaching moved towards learning (Barr and Tagg, 1995); this in turn, would encourage a student-centered approach to teaching and learning in higher education that will facilitate the production of university graduates who possess not only knowledge, but skills and competencies as well. Fostering such outcome challenges the higher education to develop, implement and evaluate teaching and learning approaches that are student-centred. To effectively address these issues in higher education, policies on higher education are steered to highlight the need to develop a more well-rounded university graduates. For example, the Bologna process in Europe has emphasized on student-centered learning, outcome based education and competencies to achieve such aims (Kolmos, 2010). To keep abreast, the Malaysia's higher education has introduced the outcome-based education (OBE) in the late 1990´s (Puteh, 2013).

OBE is a method of curriculum design and teaching and learning activities that focuses on what students can actually do after class. In OBE, the learning outcomes of the course does not only focus on students' possession of knowledge, but also on their development of appropriate skills and qualities upon graduation. This equal emphasis on both knowledge and skills has prompted university teachers to enquire: *What do we want our students to learn? Why do we want them to learn it? What is the best ways to help student to learn it? and how do we know that they have learnt it?*. Hence, the OBE emphasizes on active learning where students are expected to tackle many challenging tasks other than memorizing and reproducing what has been taught. To realize this aim across Malaysian public universities, the Malaysian Qualification Framework (MQF) was established at the end of 2007 (Pelan Strategik Pengajian Tinggi Negara, 2007). In line with its role as the reference for quality in Malaysian higher education, the MQF emphasizes on the following learning outcome domain:

i. Knowledge
ii. Practical skills
iii. Social skills and responsibilities
iv. Values, attitudes and professionalism
v. Communications, leaderships and team skills
vi. Problem solving and scientific skills
vii. Information managements and lifelong learning
viii. Managing and entrepreneurial skills

As a teacher educator who teaches in an educational university in Malaysia, the researcher has to include those learning outcome domains in the course to achieve the OBE aims. Regardless, the researcher's concern is not only on the policy change in higher education, but also on the development of Malaysian school policy and how it affects the ways pre-service and in-service teachers are being taught in teacher education institutions.

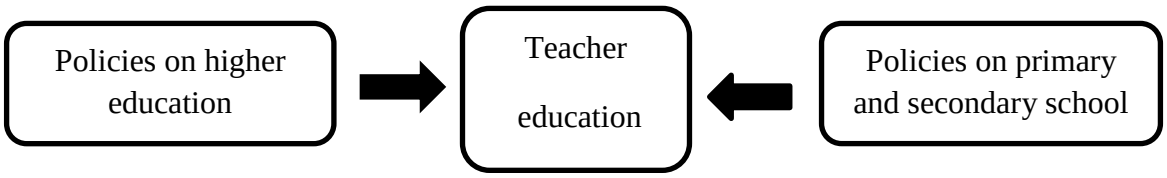

Figure 1: Teacher education is influenced by both policies on higher education and on primary and secondary school

As depicted in Figure 1, teacher education does not take place in a vacuum. Teacher education should correspond to the policy changes in higher education, as well as in primary and secondary school policy. Developments and changes in national policies and initiatives have implications on how teachers are being prepared. Furthermore, teachers need to stay abreast with the changes in local and national standards. Recent development with regards to school teachers and school children is the introduction of the School-Based Assessments (SBA) by the Malaysia´s Ministry of Education in 2011 (Panduan Pengurusan Pentaksiran Berasaskan Sekolah, 2012). The rationale of the SBA implementation is to:

i. Develop learners´ physical, emotional, spiritual and intellectual abilities
ii. Reduce exam-oriented learning among learners
iii. Evaluate learners´ learning progress

iv. Enhance teachers´ integrity in assessing, recording and reporting of learners´ learning.

SBA is a holistic, integrated and standard-referenced assessment approach that emphasizes on the development of cognitive and affective psychomotor of a school student. There are two categories in SBA: academic and non-academic. School teachers are given the responsibility to conduct and administer SBA by using instruments, rubrics and guidelines. In fact, they should plan, prepare the instruments and administer the assessment during the teaching and learning process (Panduan Pengurusan Pentaksiran Berasaskan Sekolah, 2012). In other words, school teachers need to assess their students in ways different from the ones they are used to. This however, raises the question; *do the in-service teachers or pre-service teachers have the ability to meet such demand?*

Like any other profession, teachers are urged to be more responsive and relevant to the on-going changes regarding schools and school students. In particular, the role of today´s teachers is not limited to teaching and classroom matters; they are also carrying multiple roles like being a researcher, a curriculum planner, a team leader, a decision maker and the one that inculcates creativity, intellectuality, problem solving ability and critical thinking skills. For this reason, teachers need to equip themselves with necessary skills, attitudes and disposition to correspond with the ever-changing complexity of the school classrooms, such as diversity of students´ backgrounds, inclusive classrooms and ongoing development of technologies (Dean, 1998 and Goodnough, 2006). Edmundson (1990) argued that a teacher education programme does not provide the foundations to help future and new teachers develop their skills and competencies relevant to their future professions as school teachers. He added:

> *New teachers will be unable to resist the powerful conservative effects of the schools and may themselves become the obstacles of change (p. 722).*

This statement implies that teachers need to be prepared for any change to take place in schools. Entailing issues of policy change, both in Malaysia's higher education and schools, have reflected on my role as a teacher educator who prepares teachers for both Malaysian primary and secondary schools. Hence, I queried:

i. How to implement OBE in my teaching and learning?

ii. How to prepare teachers (pre-service and in-service teachers) that correspond to current school demands?
iii. How to continually prepare teachers according to the current demands, and how to sustain the new pedagogical practice in teacher education?

A new approach in teaching and learning practice seemed to be an essential element in giving teachers the responsiveness they need to meet with new developments in school policies.

1.2 Conception of Learning and Constructivism

Early understanding of what constitutes learning was contributed by the behaviourist school of thought, who postulated learning as a change in observable behaviour caused by external stimuli in the environment (Skinner, 1974). Early behaviourist scientists such as Thorndike and Pavlov claimed that observable behaviour indicates that the learner has learned, and not what is going on in his cognitive structure. The research on learning remained flourished within behavioural tradition of psychology until 1960s (Shuell, 1986).

Between 1960s and 1970s, the psychology of learning began to change from a behaviouristic to cognitive orientations (Shuell, 1986) since there was a shift from environmental influences towards human factor to describe learning. This shift began with the development of cognitive psychology that placed great emphasis on learner's information processing as the central cause of learning. This is from the response of cognitive psychologists who claimed that not all learning is observable and there is more to learning than a change in behaviour. Cognitive psychology is concerned with various mental activities such as perception, thinking knowledge representation and memory. Hence, the cognitive psychologists posit learning as internal process, and the amount of learning depends on the processing capacity of the learner, the amount of effort expended during the learning process and the learner´s existing structure (Ausubel, 1974).

Learning, as Marton and Booth (1997) defined, is how learners perceive and understand the world, and about "meaning making". To describe meaning making, cognitive

psychologists have introduced “structure” such as schemata and heuristics to represent knowledge in memory (Palincsar, 1998). Therefore, knowledge is not imposed from outside but rather from inside the learners. The schemata undergoes assimilation or accommodation process as the learners are exposed to new understandings, experiences, actions and information. Change in schemata (either through assimilation or accommodation) reflects that learning has occurred. Learning (whether in cognitive, affective, interpersonal or psychomotor domains) involves a process of individual transformation and for this reason, people actively construct their knowledge (Biggs and Moore, 1993). An individual’s construction of knowledge is true to that person but not necessarily to anyone else since learners produce knowledge based on their beliefs and experience in situations that differ from person to another (Cobb and Bowers, 1999). These were the basic assumption that gave rise to constructivism.

Constructivism stemmed from the burgeoning field of cognitive science particularly from Jean Piaget’s work and the socio-historical work of Ley Vygotsky. According to Simpson (2002), constructivism is an epistemology or philosophical explanation about the nature of learning. It shares characteristics with social cognitive theory that assumes persons, behaviours, and environment interact in reciprocal fashions (Bandura, 1997). However, constructivism differs from conditioning theories that stress environmental influence on the learners; it also contrasts with the cognitive information processing theory that places the locus of learning within the mind, with little attention to the context in which it occurs (Schunk, 2009).

Constructivism can be explained from three different perspectives of *exogenous, endogenous* and *dialectical* (Schunk, 2009). *Exogenous constructivism* emphasizes on the notion that knowledge acquisition is represented by a reconstruction of structure on the external world. This view implies a strong influence of external world in knowledge construction, which may include experience and teaching. In contrast, *endogenous constructivism* refers to the mental structure to explain knowledge acquisition whereby knowledge is developed through cognitive abstraction from previously acquired knowledge–not directly from environmental interactions as in exogenous constructivism. *Dialectical constructivism* highlights the interaction between persons and environments to explain knowledge construction. Construction of knowledge is neither merely from

external world, nor from the results of mental structure abstraction; rather, it is the result of mental interaction with the environment.

The basic premise of constructivism is that learning occurs by fitting new understanding and knowledge into old understanding and knowledge (Fry, Ketteridge and Marshall, 2009). This underlies many learning principles that has affected theories and research in learning and development (Schunk, 2009). A learning environment that reflects constructivism principles, as characterized by Brooks and Brooks (1999), is shown in Table 1:

Table 1: Principles of constructivism learning environments

• Posing problems of emerging relevance to students
• Structuring learning around primary concept
• Seeking and valuing students´ point of view and opinions
• Adapting curriculum to address students´ suppositions
• Assessing student learning in the context of teaching

Source: from Brooks and Brooks (1999), pg35-96

From curriculum perspectives, constructivism emphasizes an integrated curriculum whereby a topic is studied from multiple perspectives. From teaching perspectives, constructivism contradicts to the traditional delivery of instruction to learners. Rather, the lesson is structured in a way that engages learners to the teaching and learning process by active participation, which allows them to construct their own understanding. In a constructivism classroom, learners are taught to be self-directed and take active role in their learning by setting goals, monitoring and evaluating progress, and exploring interest (Bruning at al., 2004). As a result, constructivism learning environment gives students ownership of what they've learned and encourages higher retention, as the learners seek meaning for themselves and not the meaning constructed by their teachers (Hmelo and Evensen, 2000). A constructivism learning environment such as cooperative learning, peer tutoring and class discussion are designed in a way that allows students to play an active role (mentally, physically, socially and emotionally) during the learning process. PBL is also aligned with the constructivism framework that views learning and teaching as an active and meaningful inquiry by learners. Likewise, Savery and Duffy (1995) specifically described PBL from a constructivism framework:

i. *Learners construct their own knowledge* - Learners are encouraged and expected to think both critically and creatively with multi-directional interactions with the problem, their peers, the resources, and the instructor. Learning is no more a process of transmitting information from others to the learners themselves; rather, it's a process of immersing themselves into a problem situation, one that allows them to monitor their own understanding.
ii. *Problems as stimulus and organizer for learning* - All learnings arise from discussing the problem in class, generating hypotheses, identifying relevant facts related to the problem and identifying learning issues based on their analysis of the problem.
iii. *Knowledge is socially negotiated* - Social negotiation of meaning is an important part of the problem-solving team structure. Students' understanding of the content is constantly challenged and tested by others.

Learning through group work and collaboration explains for how individuals construct and transform their knowledge and conceptual understanding through communication among group members. The emphasis on collaborative learning in PBL reflects *dialectical constructivism* explanations for how individuals construct and transform knowledge and conceptual understanding through dialectical activity. This dialectical constructivism entrenched from Vygotsky´s theory of learning as social process. In particular, Vygotsky proposed that social interaction leads to knowledge construction in which communication serves as the main tool that promotes thinking, develops reasoning and supports activities like reading and writing (Vygotsky, 1978). Because knowledge is socially constructed, collaboration and exchange of ideas among group members lead to the inculcation of social and communication skills. Collaborative learning is valued, not only for the pragmatic value of supporting the development of team-work skills needed in professional practice (Maudsley & Strivens, 2000), but also in recognizing the view that learning is not an isolated, individual activity.

Accordingly, Malaysia´s National Higher Education Action Plan (2011) recommended that lecturers/university teachers in higher education institutions adopt student-centred learning approaches in their classrooms in order to achieve both the OBE aims and the quality of teaching and learning in higher education, in which the Problem Based

Learning (PBL), case study and Project-Oriented Problem Based Learning (PBL) were among the approaches suggested. In this research, I choose to implement Problem Based Learning (PBL), a method that reflects my belief in emphasizing learning and advocating the constructivism learning principles. As a teacher educator, my desire is always to reflect my own teaching towards constructivism. I believe that pre and in-service teachers should be given the opportunity to explore and reflect upon their ideas, and to enquire and share their thinking in a group learning environment.

1.3 Problem Based Learning (PBL)

Since its inception in the late 1960s at McMaster University (Barrows, 1996), PBL has been applied in many institutions and in a variety of fields. The flexibility and diversity of PBL make it possible for the method to be incorporated in different ways, in a variety of subjects and disciplines and in various contexts (Savin-Baden, 2001). In the early 90´s, PBL was further applied in different disciplines such as architecture, law and social work (Bould and Feletti, 1991). It was also applied in professional education like nursing, design, optometry, architecture, law and business (Chappel and Hager, 1995). Henceforth, PBL was practised in a variety of approaches, depending on the discipline of a course, objectives of a curriculum and need of an institution.
Entailing the PBL dissemination is the variation of the PBL definitions. In their seminal writings on the fundamental characteristics of PBL, de Graaff and Kolmos (2003) argued that PBL can be defined from model practices in a specific institution and from learning principles. With regards to the PBL definitions by models practices in specific institutions, three models of PBL have emerged: the McMaster Model in Canada, the Maastricht Model in the Netherlands and the Aalborg Model in Denmark. The commonalities and differences across the models are discussed accordingly.

The McMaster PBL model was developed in the late 1960s at McMaster University, Canada. The PBL implementation was driven by the need to respond to the students´ unsatisfactory clinical performances due to the emphasis on memorization of disintegrated medical knowledge in conventional medical education (Barrows and Tamblyn, 1980). The focus of the learning was on patient cases or complaints. The students systematically analysed patients´ complaints before they formulated questions, identified the information needed with regards to the questions and selected their own

learning goals. Therefore, the integration of knowledge from different disciplines occurred while dealing with the cases. The following Table 2 describes the McMaster Model, as characterized from the original work of Barrows (1996):

Table 2: McMaster PBL model

- Student-centred learning
- Students work in a small group with the guidance of a tutor
- Tutor acts as facilitator or guide
- Begin with authentic and ill-structured problems as the driving force for enquiry
- Problem as a tool to achieve required knowledge and skills necessary to solve the problems

Source: from Barrows (1996), pg5-6

To complement the aforementioned McMaster PBL Model characteristics, Woods (2006) has laid out typical roles of educators in facilitating the students. They include:

(1) being student-centred and empowering students with tasks in learning process
(2) maintaining standards by assessing the process instead of traditionally being the assessor
(3) having confidence, skills and coaching quality in the process of problem solving, team work, conflict resolution, change managements astute questioning and critical thinking (Woods, 2006, pp. 4-8).

In Europe, Maastricht University and Aalborg University have established a PBL model in medicine and in engineering respectively. Being a relatively young university, both Maastricht and Aalborg have developed their respective PBL model without adhering to the traditional norms or practices like their older counterparts. Like the original McMaster PBL model, the Maastricht PBL model focuses on cases to be discussed. It provides a structured approach to a PBL session in which students work together in small groups with individual roles following seven defined steps as listed in Table 3:

Table 3: Seven steps of the PBL learning process in Maastricht PBL Model

Step 1: Clarify	Clarify terms and concepts not readily comprehensible
Step 2: Define	Define the problem
Step 3: Analyse	Analyse the problem
Step 4: Review	Draw a systematic inventory from Step 3
Step 5: Identify learning objective	Formulate learning objectives
Step 6: Self study	Collect additional information outside the group
Step 7: Report and synthesise	Synthesize and test a newly acquired information

Source: from Schmidt (1983), pg13

Dolmans et al. (2001) suggested that tutors need to be prepared to ask stimulus questions and lead students through the elaboration of materials. An effective facilitation will encourage students to reflect on their own processes, both as individuals and as a group responsible for guiding students to identify the key issues in each case. The role of tutors is to be active during the learning process; they are to be directive only when needed in order to assure that the group stays motivated and on target, and able to achieve their learning goals. Therefore, the tutors remain focused on the process rather than on the subjects; they facilitate students to define the problems, brainstorm, elaborate and reflect in small group activities (Moust, et al., 2005).

Since 1974, Aalborg University (AAU) has utilized the Problem and Project-Based Learning (PBL)–an innovative teaching and learning model that integrates PBL into project-based learning with a substantial focus on project activities throughout the curriculum (Kolmos, 1996). The drivers of the PBL adoption in Denmark came from the strong movement of the students and from the demand of the industry for new competencies among the engineering graduates. de Graaff and Kolmos (2007) and Barge (2010) characterizes Aalborg PBL model as follows:

i. *Project*- A complex task for a group of students to deal problems that involve analysis process in planning and managing the projects. Projects are very diverse as they extend beyond a specific scope and definition.

ii. *Problem*- The starting point to initiate student group learning process that can be a theoretical, practical, social, technical, and symbolic-cultural problems

iii. *Interdisciplinary*- The problem analysis process and solutions are not confined to traditional professional boundaries, instead it cross professional discipline borders

iv. *Participant control*- Participants (students) have significant authority in making decision on their projects with the guidance of supervisors. Therefore, students feel the ownership of the learning.

v. *Exemplarity*- Selection of specific learning outcome or scientific content that is exemplary to overall learning outcome i.e. a problem is referred back to a particular practical, scientific or technical domain so that students do not learn isolated elements

vi. *Supervisors*- Facilitate student learning and strive to create a reflective learning culture (Kofoed et al., 2004) and to assist students in developing their process competencies such as communications, group management and group dynamics.

Project work distinguishes Aalborg PBL model from other PBL models; the project assignments are designed in a way that reflects the reality in order to motivate and challenge the students. Learning occurs when students apply their knowledge on real engineering problems. This group of students work on a project in each semester, and the number of members in the group will be reduced towards the end of the program. For the students to manage the group project, they need to undergo a learning process that emphasizes on project management, collaboration and research methodology. In a learning process typical to Aalborg PBL Model, the group learning begins by meeting in the early semester with the aims to identify problem, formulate research questions, determine suitable methodology, and identify relevant theories in relation to the project under scrutiny. The group meeting also serves as a platform for the students to plan project work assignments and review comments and drafts. Twice a month or according to the group need, they will meet with their supervisor, who will facilitate them through comments and critiques on their project drafts. They also discuss theories, methodological problems and even rapport among group members. Across the different PBL models aforementioned, they were similarities between McMaster-Maastricht model and that of Aalborg whereby the former focuses on process, while the latter focuses on project (de

Graaff and Kolmos, 2003). In spite of their variations, they all share common features of PBL: they include a problem to initiate the learning, active learning strategies, project-based or problem-oriented, collaboration and cooperation, and attainment of generic and transferable skills.

From distinctive PBL definitions by models practice in particular institutions, several PBL proponents (see de Graaff and Kolmos, 2007 and Savin-Baden, 2000) attempt to define PBL by merging the characteristics of PBL and project-oriented PBL because these models uphold common learning principles. According to the seminal works on PBL by de Graaff and Kolmos (de Graaff and Kolmos 2003, 2007), the PBL learning principles can be distinguished by three approaches: cognitive, contents and collaborative:

i. The **cognitive learning approach** means that *learning is organized around problem* and will be *carried out in projects*. The problem is the starting point of the learning process, place students to learn in context, and learning is based on students´ learning experiences.
ii. The **contents approach** concerns with *interdisciplinary learning* that involved divergent of the subject related boundaries and methods. The contents approach also emphasize on linking the theory and practice
iii. The **collaborative or social approach** involves *team-based learning* whereby learning occur through dialogue and communication between group members. Students learn from each other by sharing the knowledge and organizing the group learning process.

Kolmos (1996) and de Graaff and Kolmos (2003) define project work PBL based on the interplay between involvements of the students in the projects and the degree of teacher-centred planning:

Table 4: The project model proposed by de Graaff and Kolmos (2003, 2007)

Project model		Characteristic
i.	**The Task Project**	As the name suggests, the tasks for students are pre-determined by the teachers. Students are required to strictly follow what has been decided by the teachers.

ii.	**The Discipline Project**	Though the disciplines and methods are chosen by teachers, students still have the freedom to define and formulate the problems within the framework.
iii.	**The Problem Project**	This is a full-scale project model whereby group of students are given the freedom to work on vast of disciplines and subject methods.

Source: from de Graaff and Kolmos (2003, 2007)

Savin-Baden (2000, 2007) proposed five PBL models that consist of attainment of knowledge, PBL for professional work, PBL for interdisciplinary understanding, PBL for cross-discipline learning and PBL for critical competencies. Essentially, these models stress the importance of aligning and combining different elements of curriculum that consist of knowledge, learning, problem scenario, students, facilitators and assessments. The PBL definition in the present research is informed by the definition offered by the above scholars. To clarify, the method is characterized by:

i. a learning environment that is student-centred and occurring in small group
ii. the use of problem cases or scenarios that initiate the learning, with the researcher and the local practitioner acting as facilitators, and
iii. emphasis on the development of knowledge and skills.

1.4 PBL in Malaysian Higher Education and in Teacher Education

Since this research aims at implementing PBL in Malaysian teacher education, this section provides an overview of the PBL implementation both in Malaysian higher education and teacher education. In recent years, PBL has become one of the promising innovations in Malaysian higher education teaching and learning settings and has gained considerable prominence. 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 in Malaysian higher education lanscapes.

For example, the Universiti Teknologi Malaysia (UTM), a public, technology-based university spearheaded PBL within its various engineering schools. Aiming to produce

higher 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). In the University of Malaya (UM), Said et al., (2005) pioneering the implementation of PBL at the Department of Chemical Engineering, due to the demand of equipping engineering graduates with analytical skills, critical and lateral thinking, technical skills, team work and time management. Favourable outcomes from this pilot implementation encouraged other faculties within UM to initiate PBL in their own courses. For examples, PBL was incorporated in the Faculty of Education to accomplish the goals of preparing future school teachers with new competencies and skills.

In the University of Science Malaysia (USM), PBL in operation in its medical school. Throughout the 5-year program for both medical and dental surgery degrees, the curriculum is problem-based and community oriented. PBL sessions here are combined with lectures, practical, fixed learning modules and clinical clerkship. For example, a PBL session will last for 2-3 hours and consist of a group of 14-16 students with tutors who aim to facilitate students' learning (Barman et al., 2006). Overall then, the aims of PBL implementation in Malaysian higher education across the disciples is to equip students with skills and competences. With regards to the fields of implementation, PBL in Malaysian higher education is more integrated into engineering and medical schools, than in other subject areas. Since PBL is relatively new to Malaysian undergraduates, the initiators (Mohd-Yusof et al., 2005 and Said et al., 2005) proposed a hybrid PBL approach and a gradual PBL introduction throughout the academic years.

In teacher education, PBL has been implemented in both graduate and undergraduate level in a variety of courses including in Foundations of Education, Inclusion Classrooms, Elementary School Curriculum, Introductory Educational Psychology, Educational Research and Methods (Levin, 2001), and Science Education (Watters, 2007 and Goodnough, 2003). The drivers for PBL implementation in teacher education varied from one case and another, but mostly they serve to prepare pre-service teachers to be more relevant in their future teaching professions.

Issues such as diversity of students´ background, inclusive classrooms and ongoing development of technologies (Dean, 1998 and Goodnough, 2006) have changed teachers' role in schools; no longer they serve to impart knowledge, today's teachers are now

involved in inculcating creativity, intellectuality, problem solving ability and critical thinking skills among school students. Hence, both in-service and pre-service teachers need to equip themselves with necessary skills, attitudes and disposition in order to correspond with the ever-changing complexity of the school classrooms. PBL is seen as a platform to acquire knowledge and skills, and to prepare the them for varied roles through the PBL learning process that involves authentic PBL scenarios, group collaborations, assessment and self-directed learning. This practice, as Finkle and Torp (1995) described, is a curriculum development and instructional system that simultaneously develop both pre-service teachers´ problem solving strategies and skills by way of placing them in an active role of problem solvers. In a similar argument, De Simone (2008) contended that a PBL real-life problem scenario could enhance pre-service teachers' ability to define problems, and apply practical and literature-based resources in search for solutions. Hence, the method is effective in helping pre-service teachers to adopt a deep approach to learning apart from enhancing their confidence in teaching science in schools (Watters 2007).

As a relatively new teaching and learning approach in teacher education, PBL was criticized for its compatibility with teacher education. No doubt, it suits very well with science teacher education programs where problem scenarios are easily available from practice in the profession and from the literature related to issues of science education in school settings (Peterson and Treagust, 2001). McPhee (2002) suggested the teacher education itself should be seen in the frame of constructivism and devoted, and not limited to child-centred perspective. For example, a PBL problem scenario of *"an excel, highly-motivated secondary school students with the sudden drop off of achievement, and change in behaviour"* will give the opportunity for pre-service teachers to explore interrelated issues like motivation, learning theories, learning behaviour, and national standard and policy. Therefore, from a specific problem scenario, pre-service teachers will have the opportunity to experience interdisciplinary learning, which represents the central principles of PBL.

Levin (2001) argued on the relevance of PBL application in teacher education course. The purpose of redesigning an undergraduate teacher education course is to make learning more relevant and engaging, and to help pre-service teachers perceive their profession as worthy of their intelligence and passion. Likewise, Dean (1999) perceived PBL as an important vehicle to expose the pre-service teachers to situations they are likely to face as

professional educators; it also simultaneously allow them to practise a teaching and learning approach that encapsulates the central tenet of constructivism and social constructivism learning theories. In conclusion, PBL in teacher education is being implemented mostly at the course level, and implementation at the programme level is yet to ventures. Similar with the aims of PBL implementation in Malaysian higher education, PBL implementation in teacher education is striven to inculcate skills and competences among both in-service and pre-service teachers.

1.5 Research Questions and Objectives

This research is driven by an overall aim to systematically develop, implement and evaluate a PBL design for Malaysian teacher education. Congruent with the overall aim, the main research question is formulated as follows:

What are the impact, potentials and constraints of PBL implementation in Malaysia and in teacher education?

Following this main research question, the research targets to answer the following research questions:

i. *What is the present knowledge of the impact, potentials and constraints of implementing PBL in Malaysia and in teacher education?*
ii. *In what ways can PBL design be suited to the Malaysian teacher education?*
iii. *What are the potentials and constraints for the implementation process of the PBL design?*
iv. *How do the PBL design implementations impact the students´ learning and their learning environment?*

The first research question served to provide fundamental aspects of PBL designs by documenting the impact of PBL on student learning; it also aimed to discover the potential and constraints of PBL implementation. This information was elicited from previous studies of PBL implementation in Malaysia, PBL implementation in teacher education, and also from an exemplary case of PBL practice. The second research question served as a design-oriented query that strived to develop a PBL design that corresponds to the local context, in this research the context is Malaysian teacher education. Outcome from the first research question were utilized to inspire the PBL design development in the second research question. The intact PBL designs was brought

to practice through implementation phase in Malaysian teacher education context whereby the potential and constraints of the PBL design implementation will be determined, and the impact on student learning and student learning environment is reported as stated in the third and fourth research question respectively. To further guide the research inquiries, the research objectives were formulated as follows:

i. To document present knowledge on the impact, potential and constraints of implementing PBL in Malaysia and in teacher education.
ii. To develop PBL designs correspond to Malaysian teacher education.
iii. To determine the potential and constraints for the implementation process of PBL designs.
iv. To determine the impact of PBL design on students' learning and students´ learning environment.

1.6 Conclusions

This chapter linked how the change in the policy, the recent focus of the higher education and the need to better prepare teachers for the primary and secondary schools as the motivation to shift towards a student-centred learning approach in the university; in this research, the approach selected is the PBL. As a teaching and learning approach that emphasize on learning rather than teaching, PBL entrenched from constructivism principles that uphold the conception of learners actively constructed knowledge during the learning process. In defining PBL, it can be defined from model and learning principles. To define PBL based on model, the McMaster, the Maastricht and the Aalborg PBL model are compared and contrasted. Both McMaster and Maastricht focus on practice while Aalborg model focuses on the projects. In defining PBL based on learning principles, three approaches has been identified: the cognitive learning approach, the content approach and the collaborative approach. Overview of PBL implementation in Malaysian higher education and in teacher education indicated that PBL are compatible in both domain due to its favourable results. Four research questions and research objectives are formulated based on the aforementioned issues whereby the first and the second research question involve PBL designs development and the third and the fourth research questions involve implementation and evaluation of the PBL designs.

1.7 Reader Guide

This chapter serves as an overview for the subsequent chapters in the thesis. In Chapter 2, *Research Methodology* in particular, reports the methodological approach adapted in this research. It begins by discussing academic discourse on various methodologies to research new practices in the classrooms. Design Based Research (DBR) is deemed a suitable methodology to address the research need and methodological alignment is presented to show the alignment between design phase, research questions, data collection and data analysis and research trustworthiness. Chapter 3, *PBL Design Development and Implementation* demonstrates how this research was carried out according to the three design phases;

i. Phase 1: Compiling initial findings for PBL design
ii. Phase 2: Developing the PBL design for Malaysia setting
iii. Phase 3: Implementing the PBL design in Malaysia setting

In a nutshell, the phases involved (1) compilation of initial findings from variety of sources (Phase 1), (2) how these initial findings contribute to the development of the PBL design (Phase 2) and (3) process and procedures involved in implementing the PBL designs in Malaysian teacher education (Phase 3). Subsequently, along with the PBL design implementation in phase 3, this phase is also a data collection and data analysis phase whereby the empirical data on the impact of PBL design implementation on students´ learning and their learning environment were collected and analyzed. Chapter 4, *Empirical Research Findings* specifically focus on presenting these empirical research findings during the PBL design implementation in the Universiti Pendidikan Sultan Idris (UPSI), Malaysia. The findings is presented in two sections; first section is qualitative findings that reported in the form of a journal article and the second section reported the findings from quantitiative questionnaire. The final chapter, Chapter 5, *Revisiting Research Questions and Perspectives* is presented based on the four research questions. Each of these research questions are revisited to discuss it thoroughly and from different perspectives.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Introduction

This chapter begins by discussing different methodological approaches to researching learning and practice in classrooms. Design Based Research (DBR), experimental research and action research were compared from different perspectives to determine which methodological approach was most viable to address the research questions. Accordingly, DBR was deemed the most feasible methodology to guide the overall design phase. In each of this design phase, specific data collection techniques and analysis are employed in accordance to DBR and research questions. This chapter concludes by reporting the research trustworthiness in order to explain the rigour and quality of the qualitative research.

2.2 Methodologies of Researching New Practices

The most feasible methodology for this research was thought to be the one that could (1) address contextual elements such as local policies, norms and practices, (2) give impact on students' learning and (3) lead to the sustainability of a new pedagogical practice in an institution. It is often difficult to implement an innovative learning practice like the PBL because the innovation is too different from the demands and constraints of contextual needs. Social scientists who view educational research as a mean of improvement tend to take such criticism more seriously that those who them as a mean to strive for knowledge contribution (for example see van den Akker et al., 2006). Because PBL originates from western higher education institutions, adapting it in an Asian context may require a considerable change of curriculum. As Kolmos et al. (2009) mentioned:

> *In engineering, the practical conditions are quite different from those in the health sciences and the cultural values in Asia or South America result in different communication patterns and decision strategies on teams. As a consequence, it is not possible for Asian or South American universities to copy a western curriculum and learning approach (p.10).*

This above statement implies the need to adjust the curriculum according to the disciplines of specific country, rather than emulating the intact curriculum model from a particular institution. de Graaff and Kolmos (2007) posited that implementing the PBL curriculum involves a gradual adaptation to a local condition by addressing contextual elements during the design of the practice. In a wider perspective of curriculum design, emphasizing the needs of educational goals, along with the social, political and economic traditions of a particular institution is crucial (Kolmos et al., 2009). Similarly, Stojcevski and Du (2009) claimed that the design of a PBL curriculum depends on the objective of a particular institution. Considering these contextual elements would result in a PBL curriculum that is more relevant and effective in practice.

Putting forward the above issues, the research has adopted DBR as the research methodology due to its principles that strive to make learning research more relevant for a particular context. In particular, the method addresses a needs and norms of a local context, which will lead to a research findings that are scientifically trustworthy and useful in practical sense.

First conceptualized by Ann brown in 1992 (Brown, 1992), the DBR is a relatively new research methodology for educational research (Kolmos, 2014 and Anderson and Shattuck, 2012). Hence, it is often associated and compared from a variety of perspectives with the more established research methodologies such as experimental research and action research. Both action and experimental studies deal with the research in a classroom as DBR, but what distinguishes the latter from the preceding approaches?

Kolmos (2014) highlighted that both DBR and action research are pragmatic; they are both considered as an applied research approach. Having analysed the quality of a DBR study, Anderson and Shattuck (2012) highlighted the differences between DBR and action research from two aspects: partnership and theoretical. In an action research, the educator is both the researcher and the practitioner while in DBR, the emphasis is on the

partnership between these two parties. Partnership with a local practitioner is important in order to ascertain how much freedom is allowed in a curriculum while ensuring the feasibility of the initial framework. Apparently, the local PBL practitioners know more about the complexity of the culture, objective, mission and vision of operating an educational intervention. On the other hand, a researcher/designer is well-trained to conduct rigorous research. Therefore, it is imperative that both parties collaborate for the PBL design affect changes in the real-world context. Theoretical contribution in DBR involves developing practical design principles– a key strength of the methodology compared to other research approaches. An action research, on the other hand, does not aim for theoretical contribution since it focuses on solving classroom problems.

DBR and experimental research are highly associated since the former's inception as a research methodology in 1992. The DBR initiator, Brown, (1992) has expressed her dissatisfaction towards the experimental approach that is limited to explain or predict learning in classrooms. As she proposed, the important challenge is to *develop a methodology of experiment interventions that aims to develop theories of teaching and learning from multiple interaction of people in a complex social settings.* Likewise, Collins et al. (2004) have contrasted experimental research and DBR from several aspects. An experimental research typically involves a single dependent measure while a DBR use multiple dependent measures because the latter's findings are the result of multiple interaction of measures. The research procedures in experimental research are fixed but the process in DBR is very flexible and interactive because the latter emphasises on adaptation to local conditions. In an experimental research, the researchers made all the decisions while in DBR, decisions are mutually developed from the interaction and collaboration between the researcher, the practitioner or even the participants of the study. The following section describes DBR as a research methodology in this research.

2.3 Design Based Research (DBR) as Research Methodology

Research methodology is a plan or framework for a study. It is used as a guide from broad assumption to detailed methods of data collection and analysis. The Design Based Research (DBR) is deemed a feasible methodology to address concerns of designing and enacting of teaching and learning innovation like the PBL–a practice that is theoretically grounded and co-constructed in a real-world context. The methodology involves

scrutinizing the research objectives that involve the interplay between change in the real world learning environment on one side, and the emphasis on the rigorous educational research on the other. Wang and Hannafin (2005) defined DBR as:

> *A systematic and flexible research framework that aims to improve educational practices through iterative analysis, design, development and implementation, particularly by collaborating researchers and practitioners in a real world setting.*

According to DBR advocates (e.g: Design-Based Research Collective, 2003, Barab and Squire, 2004, and Wang and Hannafin, 2005), the underlying assumption of DBR is that learning varies according to the environment in which it takes place. The DBR emphasises on local learning environment and contributes to a more practical and relevant practice by allowing educational researchers to systematically design, implement and evaluate a teaching and learning approach in a real-world setting (Hung, 2011). Brown (1992) and Collins (1992) are widely recognized as early contributors to the DBR describe it as a methodology that requires:

i. Highlighting complex problem in real context in collaboration with practitioners
ii. Integrating known hypothetical design principles to obtain plausible solutions to the complex problems; and
iii. Conducting rigorous and reflective inquiry to test and refine innovative learning environments and to define new design principles

As a result, the gap between theory and practice is narrow, which simultaneously sustains the research rigour and new pedagogical practice. O´Donnell (2004) has summarized factors that contribute to the emergence of DBR as a methodology of researching new practice in a classroom, which include:

i. The need to measure higher order cognitive process such as reasoning and metacognition
ii. Change in the learning theories that demand a better methods to study higher order processes and instructional methods
iii. Concern of educational research that more relevant and contribute to the educational improvement.

DBR increases the relevance of learning research in a classroom since it emphasises on addressing the contextual elements from the begging of the research phase. The central focus of DBR is the understanding of the real-world practice, with the research context being the core part of the story. As a methodological approach, DBR is discussed in different journals: *Educational Researcher* (see e.g. Shavelson et al. 2003; Cobb et al. 2003), *Educational Psychologist* (see e.g: Hoadley 2004; Sandoval and Bell, 2004) and *Journal of the Learning Sciences* (see e.g. Collins et al. 2004; Barab and Squire 2004) and in a book chapter (see e.g. Reimann, 2011).

These studies proposed numerous number of phases, variety methods and levels of data collection, and approaches to data analysis according to the specific research phase to reflect the different aims of each phase. For example, Collins et al. (2004) has proposed six phases: implementing a design, modifying a design, multiple ways of analysing the design, measuring dependent variable, measuring independent variable and reporting on design research.

Reeves (2006) has translated DBR methodology into four phases: analysis of practical problems by researcher and practitioner in collaboration, development of solution informed by existing design principles and technological innovations, iterative cycles of testing and refinement of solution in practice, and reflection to produce design principles and enhance solution implementation.

In contrast, Reimann (2011) defined DBR methodology into three phases: preparation for the experiment, the experiment phase and phase of retrospective analysis. Across these proposals of DBR methodology, it can be concluded that the data that contribute to contextual understanding are most likely emphasised in the earlier phase of the study; whereas data on prototype characteristics or user reactions are most likely collected later during the implementation phase.

As for this research, the phases is divided into three design phases: Compiling Initial Findings for the PBL Design, Developing the PBL Designs for Malaysia Setting and Implementing the PBL Designs in Malaysia Setting. Theoretical, practical and contextual understandings of the PBL implementation were deemed important in the first design phase. These understandings, along with the alignment of curriculum and course analysis,

would contribute to the development of the PBL designs in the second design phase. The PBL designs would be enacted in the Malaysian teacher education context through the third design phase, the PBL designs implementations phase. The activity during this phase focuses on data collection and analysis that runs simultaneously to elicit information on the design and students' learning. The design phases were aligned to the research questions, data collection and data analysis as depicted in Table 5:

Table 5: Methodological alignment of Design Based Research (DBR)

Design Phase	Research Question	Data collection	Data analysis
Phase 1: Compiling Initial Findings for the PBL Design	1. What is the present knowledge of the impact, potentials and constraints of implementing PBL in Malaysia and in teacher education?	(Theory) Literature review on: • PBL implementation in Malaysia • PBL implementation in teacher education	Literature review
		(Practice) PBL case at Aalborg University (AAU): • Interview • Process analysis report	Inductive analytical approach
Phase 2: Developing the PBL Designs for Malaysia Setting	2. In what ways can PBL designs be suited to Malaysian teacher education?	Contextualization of the PBL designs	
Phase 3: Implementing the PBL Designs in Malaysia Setting	3. What are the potentials and constraints for the implementation process of the PBL designs? 4. How do the PBL design implementations impact the students´ learning and their learning environment?	PBL design implementation and data collection that involves: • Observations • Student written reflections • Interviews • Questionnaire	• Inductive analytical approach • Descriptive analysis

As shown in Table 5, this research was divided into three design phases:
1) The first phase was *Compiling Initial Findings for the PBL Design*, which aimed to provide initial findings that served as a foundation to develop the PBL designs.
2) The second phase was *Developing the PBL Designs for Malaysia Setting*, which aimed to develop a PBL design for the Malaysian teacher education context.
3) The third phase was *Implementing the PBL Designs in Malaysia Setting*, which aimed to enact the PBL designs in the Malaysian teacher education context (further discussion on the process and procedures involved in each design phase can be found in Chapter 3, *PBL Design Development and Implementation*).

Relationship between the design phases and the research questions was not linear in the sense that the former was devoted to answering the latter (except for the first research question). Instead, two design phases may be required to answer a research question, or one particular design phase is sufficient to answer two research questions. As depicted in Table 5, the first research question was answered in the first design phase. The completion of the first and second design phase was required in order to answer the second research question since the design activity in the second phase was developed from the outcome of the first design phase. The third and the fourth research questions were answered in the third design phase since both questions enquired on the potentials, constraints and impact of the PBL design during implementation.

The research has employed a variety of data collection and data analysis methods to answer the research questions. The data analysis was coincided with the data collection in order to drive forward multiple cycle of testings and design optimisations. For the first research question, literature review and best PBL practice in Aalborg University (AAU) were conducted to determine the impact, potential and constraints from both theoretical (literature review) and practical (PBL case at AAU) perspectives. This was aligned with the DBR methodology that emphasises on both theory and practice during the initial design stage. There was no specific data collection and analysis carried out to answer the second research question. However, the initial findings that was developed during the first design phase has served as a foundation to develop the PBL during the design activities in the second design phase. Therefore, both design phases (Phase 1 and Phase 2) were collectively accountable to answer the second research question. For the third and the fourth research questions, the research has employed observation, student written reflection, interview and

questionnaire to provide insights on constraints, possibilities and impact of the PBL design during the third design phase. It is worth mentioned here that from the begging of the design phase (Phase 1), the partnership between researcher and the local PBL practitioner was established in efforts to contextualise the PBL designs. Data collection and analysis were further discussed in the following section.

2.4 Data Collection and Analysis

Data collection and analysis were presented based on the design phase as shown in Table 5. The process included literature review, PBL case at AAU and PBL designs implementations at Malaysia. The following section specifies the number of participants involved (where applicable), the data collection technique, the relationship between various data collection techniques that either complement or triangulate each other and the data analysis approach.

2.4.1 Literature Review

Literature review contributed to the theoretical elements in the first design phase of the study. Kolmos (2014) proposed that literature review should focus on arguments of practicing PBL and the impact of the practice. In this research, the literature review was conducted to gain insights into challenges and issues of PBL implementation in Malaysia and also to determine how PBL affected the learning of pre-service teachers. In addition, this literature review works have informed the researcher on the affordances and barriers of PBL implementations. Since this research adapted a systematic reviewed works, the review process started with a comprehensive searching technique, followed by the standard review process.

To begin the review process, the previous empirical research articles that served as the data sources were searched thoroughly to obtain most of the relevant empirical research articles, if not all. These empirical research articles were retrieved from several key bibliographic databases of education and social science research, such as Educational Resources Information Center (ERIC), British Educational Index, Web of Science (for Science Citation Index, Social Science Citation and Art and Humanities Citation Index), PsycINFO, key research journals (e.g. European Journal of Teacher

Education and Asia Pacific Journal of Teacher Education) and searches in System for Information on Grey Literature in Europe (SIGLE) for grey literatures.

As stated in the Table 5, the review work focus in two fields; PBL implementation in Malaysia and PBL implementation in teacher education. For review work of PBL implementation in Malaysia, the keywords "*problem based learning*", "*PBL*", "*Malaysia*", and "*higher education*" were combined and returns numbers of potential articles to be included in the review work. As the name implies, the articles should reported on the PBL implementation in Malaysian higher education regardless of fields of implementation. The articles also should reported on the impact of PBL on student learning, potential and constraints of PBL implementation in Malaysian higher education. For review work of PBL implementation in teacher education, keywords "*teacher education*" and "*pre-service teachers*", the subject headings and keywords based on "*problem based learning*" and "*PBL*" have produced a number of titles. The periodic indices and content table of issues were searched manually by reading the article´s abstracts. The articles should present the empirical data of the PBL implementation in the teacher education domain that may include educational research methodology, psychology in education, pedagogy, philosophy in education, teaching and learning approach in school and sociology in education. A specific PBL definition was also required since PBL can be defined from a variety of perspectives; nonetheless, the definition must be broad enough to represent the central concepts of PBL. For this reason, this study has chosen the widely-accepted de Graaff and Kolmos's (2003, 2007) definition of PBL. Table 6 summarises the specific criteria for choosing articles for review purposes:

Table 6: Four criteria to select articles for review process

Criteria		**Description**
i.	Type of studies:	Original and empirical studies with primary data
ii.	Focus:	Employment of PBL implementation in two fields: a) Malaysian higher education institutions b) Teacher education context
iii.	Scope of variable:	Mainly report on the impact of PBL on students/pre-service teachers learning and possibilities and constraints which may include, challenges, affordances, opportunities and barriers

iv.	PBL characteristics:	Identification of types of intervention or learning environment which fulfill the PBL learning principles defined by de Graaff and Kolmos (2003, 2007): i. The **cognitive learning approach** means that *learning is organized around problem* and will be *carried out in projects*. The problem is the starting point of the learning process; it places students to learn in context, and learning is based on students´ learning experiences. ii. The **contents approach** concerns with *interdisciplinary learning* that involves divergent of the subject-related boundaries and methods. The contents approach also emphasisea on linking the theory and practice. iii. The **collaborative or social approach** involves *team-based learning* whereby learning occurs through dialogue and communication between group members. Students learn from each other by sharing the knowledge and organizing the group learning process.

Upon completing the selection process, a snowball method was employed whereby the selected articles were fully read to identify further relevant sources either in the content/ text or in the bibliographic section of the articles. Rickinson (2001) posits this method as a mean to achieve comprehensiveness in a literature search as the search process is continuous until no new citations emerge. Following the selection criteria, each individual article has undergone a standard reviewing process. To ensure commonality and comprehensiveness of the review process, a review framework was established, as demonstrated in Table 7:

Table 7: Review framework for selected articles

Component		**Description**
i.	Research aims	A summary of the aims of the research study as reported by the researchers in their article
ii.	Theoretical/conceptual approach	Summary of the key theoretical/conceptual assumptions that underpin the work reported (but only in so far as these are explicated and acknowledged by the authors)
iii.	Methodology	The broader epistemological and theoretical framework that surround and underpin the method of

		the study (only in so far as these are explicated and knowledge by the authors)
iv.	Validity measures	A value aim at measuring validity or reliability (howsoever conceived) that are reported by the author (s)
v.	Methods	Summarized detailed of the reported procedures of data collection and data analysis
vi.	Main findings	Summary of the study´s main findings as reported by the author
vii.	Key conclusions	Summary of the main conclusions drawn from the study´s findings by the author(s)

Source: Rickinson (2003), pg.271

The review process began by briefly reading the selected articles based on the components listed in the above table. The *research aims* of an article are a general description of what a research intended to achieve. As for *theoretical/conceptual approach*, the key assumption of theory application or theory generation is the one that underpins PBL, which includes constructivism, active learning and social constructivism. To achieve what is claimed in the articles, the *methodology* should sufficiently explain the alignment between the research approach, the data collection and the data analysis. To measure learners (either students or pre-service teachers) knowledge and skills acquisitions, the instrument or tool that was used to collect the data should also discuss the *validity measure* that may include Cronbach alpha for quantitative measure or validity value for qualitative measure. Entailing the validity measure description were *methods*, in which the author explained the procedure of data collection and the analysis approach that was aligned with the aims of the research. Next was the *main findings* that report on how the PBL implementation has affected the learners´ knowledge and skills. Some articles might have other findings that are also helpful to understand more on the impact. The last component to be reviewed was the *key conclusions* that were drawn from the main findings that may also include implications and suggestions. These review works were reported in the form of two journal articles, which can be found in *Appendix I* and *Appendix J* for full articles. Findings summary of both articles can be found in part 3.3.1, in the next chapter.

2.4.2 Data Collection and Analysis for PBL Case at AAU

An exploratory research design was adopted for the PBL case at AAU to address the research inquiry since it was deemed appropriate to gain insights, ideas and better understanding of the students' learning in a PBL environment. Six undergraduate Medialogy students were involved in the study. Their participation were voluntary; the researcher went to their group's rooms and asked for their willingness to participate in the study. All students were in their first semester–a semester devoted to prepare the AAU undergraduates to learn in a PBL environment. Two students were Danish and they were familiar with group learning since their college and high school education had emphasised on group working and collaborative learning. Another four students were international (two Lithuanian, one Turkish and one Korean) and they have never experienced group learning or PBL in their previous education. Of the six students, one was an international female student.

Semi-structured interviews (see *Appendix A* for interview guide for PBL case at Aalborg University) were conducted to obtain data on the students' learning. This type of interview was deemed appropriate in order to obtain an in-depth outlook of the students´ perspective of their learning. The interview was administered twice for each student: at the beginning of the semester (week 3), and at the end of the semester–after the students have submitted their group projects and were waiting for their group examination (week 15). Since this is an explorative study, the insights obtained during the first interview session were used to develop the interview guide for the second session.

The interview session commenced with the explanations of the interview´s purpose, confidentiality, anonymity and obtained their permissions to audio-taped the whole interview sessions. The interviews explored the students' backgrounds, their previous experience of group work, and the PBL learning process including the problem solving process, the facilitation process and the challenges. The interview was loosely structured to allow the students to form the interview from their own views and experiences (Seidman, 1998) and to minimize interviewer´s influence in their responses. Depending on the willingness of the students to share and talk, each interview session had lasted from 20 minutes to 70 minutes. To complement the inquiry on group learning process, the group process analysis reports were also obtained from the students. Group process analysis

report is a description of the assessment and analysis of the students' group work within a problem-oriented and project-organized group. It is their own analyses on project management, group collaboration and collaboration with supervisors.

The interview audio were fully transcribed using the *NVivo9* software and each interview transcript has received a unique record number for reference purposes. These interview transcripts (see *Appendix B* for a sample of interview transcript) were analyzed using an inductive analytical approach–a qualitative data analysis technique that uses detailed readings of raw data to derive themes, concepts or model through interpretations made from the raw data by researchers across the interviews (Thomas, 2006). Transcripts were read repeatedly, counting instances of common important issues to derive themes, concepts or model across the transcripts. The list of categories would lead to the emergence of themes after refinement, particularly by comparatively reading against the transcripts to seek for commonality and contradictions. The group process analysis reports (see *Appendix C* for a sample of group process analysis report) were also analysed inductively (Strauss and Corbin, 1998), whereby the raw data were read in details to derive concept/theme/model through the interpretations made by the researcher. Subsequently, concept/theme/model derived from both interview transcripts and student process analysis reports are compared to identify similarities or contradiction in the data. This steps helped to achieve rigour and quality in qualitative data. The PBL case at AAU was reported in the form of a journal article which can be found in *Appendix K* for full article, and the finding summary of this article can be found in part 3.3.2, in the next chapter.

2.4.3 Data Collection and Analysis for Implementation of the PBL Designs

The data collection and the data analysis have occurred simultaneously during the PBL designs implementation phase. Therefore, the ongoing data analysis has influenced the scope and direction of the succeeding data collection approaches. Thirty-two Master of Education (Science) students have signed up for the fourteen-week course, which was conducted once a week for three hours. Of these 32 students, five were males. Most of these students were in-service science teachers with varying years of teaching experiences, either in primary or secondary schools. However, there were a number of newly-graduated students from an undergraduate programme, either from the field of science education or pure sciences. Consistent with the DBR methodology, the data were collected

from multiple sources including from observations, student´s individual and group written reflection, semi-structured interviews and questionnaire as shown in the following table:

Table 8: Data collection according to PBL problems and weeks

PBL Task		**PBL1**				**PBL2**			**PBL3**		
Week		5	6	7	8	9	10	11	12	13	14
Data collection technique	Observation	√	√	√	√	√	√	√	√	√	
	Student written reflection (individual)				√			√		√	
	Student written reflection (group)				√			√		√	
	Interview										√
	Questionnaire										√

The observations were made during the group learning process, apparently each week as depicted in the table 8. In PBL, group learning process may include identifying the facts and ideas from the PBL scenarios, generating the learning issues and hypotheses and identifying plan of actions towards finding solutions to the problems. Observations were also aims to recording instructional sequences and student interactions which included facilitator-group, facilitator-student, and student-student. Robson (1999) argues that observation technique provides researchers with "real life" in the "real world" data due to its directness to watch what participants do and listen to what they say.

The observations were used to create a rich description of the classroom environment and assist in understanding the development of the learners´ conceptions. During the observation, the researcher has also used informal conversation interview (Patton, 1990) with either the individual or the group of students. The informal conversational interview occurred during and after the scheduled class sessions, and it flowed naturally. Since the researcher is also the facilitator, the observations were classified as participant observations of which the researcher participates in the situation while observing and collecting data on the activities, people and physical aspects of the settings (Gay et al, 2009).

The observations were documented in field notes to (1) record and compile events that took place during the class activity and (2) describe information on what have directly been seen or heard on-site throughout the course of the study. There were also reflective writing of the field notes. This represented the reactions to the observations, experiences and thoughts during the observation sessions. All field notes were gathered and analyzed to produce list of schemes based on the emerging themes.

The student written reflection aimed to (1) gather insights on the students' learning experiences, (2) make them aware of their own learning, and (3) enhance their meta-cognitive skills in understanding how learning occurs and identify improvements. This was an opportunity for the students to reflect on the way they learn, and how they–as a team member–could enhance collaboration and efficiency of their group work. Furthermore, opportunity for reflection on the learning process is an important aspect of PBL (Holen, 2000).

In this research, the student written reflections were applied for three purposes; for data collection technique, for grading (assessment) and for student learning tools (see part 3.4.4 for discussions of student written reflection both as assessment strategy and as student learning tool). For the purpose of data collection technique, student written reflections will give insights to researcher on how students learned through PBL such as dealing with the PBL problem scenarios, the group discussion strategy and conflict handling. This information served as a valuable source to re-structure or revise the following PBL cycles and provide better facilitation according to their learning experiences.

The student written reflection was executed right after the students completed their PBL cycles (week 8 for PBL1, week 11 for PBL2 and week 13 for PBL3). As shown in Table 8, two types of student's written reflection were used in the research: individual written reflection and group written reflection (see *Appendix D* for both individual and group written reflection prompt). In individual written reflection, 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 did they take up, recommendations, issues, frustration, difficulties and their suggestions to improve the class´s PBL sessions. In group written reflection, the students were asked to reflect on how they started the discussions, strategies to enhance group collaboration, their evaluations on the PBL scenario/cases, how did they address the learning issues, resources used to deal with the tasks, and any prior preparation before attending the discussions.

Observation data in the form of field notes and students written reflection have guided and informed the development of the semi-structured interview guide (see *Appendix E* for interview guide) that was conducted at the end of the semester (Week 14). The interview questions were loosely structured in order to allow the participants of the study to convey their own views and experiences (Seidman, 1998). The individual, semi-structured interview was conducted with eight randomly selected students at the end of the semester. Semi-structured interview was deemed appropriate for this research because it allowed the researcher to gain an in-depth perspective of the students' experience in learning.

The purpose of the interview was verbally explained before the interview session begins. The interviews explored the students' background information, their experiences in group work, benefits and challenges of participating in the PBL environment, collaboration with peers, problem solving, facilitation processes, the extend their PBL experiences have been relevant to their current professions as a teacher and how did they want to improvise themselves to be more competent and efficient in group working. Depending on their willingness to share and talk, each conversation had lasted for about 30 to 55 minutes and took place either in the researcher´s office or at a campus location convenient to the students. All interviews were tape-recorded and were fully transcribed (see *Appendix F* for a sample of interview transcript). Response rate is usually good in interviews; the interviewee may feel more control and opinions can be followed through; further, misunderstanding could be explained. However, one drawback of the interview was that the students may give socially acceptable answers or be influenced by the researchers. This is an important consideration since the researcher is also the lecturer/facilitator of these students. The data obtained from the interviews helped to triangulate the data from the students written reflection obtained in the earlier weeks. Triangulation is a process of using multiple methods, data collection strategies and data sources to obtain a more complete picture of what is being studied and to cross-check information (Gay et al., 2009).

The interview transcripts were analysed using an inductive analytical approach (Thomas, 2006) whereby the transcripts were read several times to determine topics and sub-topics, which were then coded as categories. The list of categories would then, form themes after further refinement, particularly by comparing each transcript to seek for commonalities and contradictions. Students written reflection were analysed in the same fashion whereby the analysis technique served to identify themes. The multiple qualitative data collection strategies and data sources adopted in the

study have led to a comprehensive view of the interacting variables. This had the strength of one particular strategy compensated for the weakness of another**.** To align with Lincoln and Guba´s (1985) suggestion to increase the trustworthiness of the research findings, the researcher have used multiple data resources and maintained a detailed research record. Concepts like ´communication´ and ´disadvantages´ or ´benefits´ were identified and labeled by jotting marginal notes. The concepts were sorted into categories, and patterns were further identified from the categorized data. Perhaps new things would have emerged to highlight area of particular interest to particular students/groups. The qualitative empirical research findings was reported in the form of a journal article which can be found in *Appendix R* for full article, and findings summary was reported in part 4.2, in Chapter 4.

This research was also use a questionnaire as one of the data collection technique. The questionnaire was specially designed to elicit students´ perception of the PBL learning environment. Table 9 shows a guide from Robson (1999) in designing a self-completed questionnaire that were used to developed the questionnaire:

Table 9: Guide in designing a self-completed questionnaire

• Specific questions (items) are better than general ones
• Closed questions (items) are usually preferable to open questions
• Offer a “no-opinion” option
• Omit the middle alternative and measure intensity
• Use of force choice rather than “agree/disagree” statements
• Question (items) order
• Wording effects

Source: from Robson, (1999), pg 247-249.

For the first guide, the questions (items) should be write in a specific form to provides more standardization. This is to avoid; wider interpretation by the respondents, greater susceptibility to order effects and poorer prediction of the behaviours as general questions (items) might offer. Likewise, close questions (items) are often preferable to avoid different interpretation by the respondents. Since questionnaire aims at a very specific information, the questions (items) should not offer any opinions to the respondents since there is research evidences that respondents will choose the option to provides opinions if it is explicitly offered (Robson, 1999).

For the respondents to choose their responses, it is advisable for the responses option to omit the middle category since the respondents using the middle category are those without strong feelings on the issues presented in the questionnaires. Use force choice statements rather than agree or disagree statements since force choice questions (items) are likely to stimulate a meticulous responses. In arranging the questions (items), there are no hard general rules to order the questions (items), but usually questions (items) are group together according to the constructs. Adopting the aforementioned guides, a questionnaire was designed to elicit students´ responses on PBL learning environment. The questionnaire was divided into two parts, as shown in Table 10:

Table 10: Questionnaire on PBL learning environment

Part	**Content**
Part 1	Demographic information of the respondents on: i. Gender ii. Age iii. Years of teaching experience
Part 2	Dimension of PBL learning environment that includes: i. General impression ii. Learning process in group iii. The PBL task iv. The facilitator v. PBL benefits and perspectives

The first part of the questionnaire queried personal information of the students. The second part consisted of five dimensions of the PBL learning environment items. The number of items for each dimension was varied and each item was accompanied by a 4-point Likert scale, with 1 denoting the most disagreeable and 4 denoting the most agreeable. Therefore, there is no middle alternative for the choice of the response in this questionnaire because:

1) it may encourage a non-committal response
2) respondents choose for middle category are those without strong feelings on the issues (Robson, 1999).

A 4-point Likert scale was used to ensure that the students select at least one response; in doing so, it would increase the rate of the response. To ascertain the internal consistency of the questionnaire, a pilot study was conducted among the seven in-service teachers who were also experiencing the PBL learning environment. According to Gay et al., (2009), three or four individual are sufficient for a pilot test and those individuals should be similar to the intended research participants. The Cronbach coefficient alpha was obtained by calculating total item correlation of all data collected using different response scale (see *Appendix F* for SPSS-generated output on the Cronbach alpha value). The pilot study results indicated that the questionnaire alpha value was .840. Cronbach alpha reliability coefficient >0.7, indicating that the questionnaire was reliable for internal consistency (George and Mallery, 2001). The questionnaire (see *Appendix H* for Questionnaire on PBL Learning Environment) were administered to the 30 students at the end of the course. For analysis purpose, the items were coded and calculated to determine descriptive-type analysis such as frequency, mode, median and mean of the data by using the Statistical Package for Social Science Version 17 (SPSS Ver 17). This quantitative empirical research findings was reported in section 4.2.2, Chapter 4.

2.5 Research Trustworthiness

Trustworthiness is a term coined by Gubba (1981) to ensure rigour in qualitative research paradigms without neglecting the relevance of qualitative research. To enhance trustworthiness of the research, the researcher has adopted many Wolcott Strategies (Wolcott, 1994) such as talk a little, listen a lot, record accurately, begin writing early, report fully, seeking feedback and write accurately. Table 11 highlights how these strategies were used throughout the course of the research:

Table 11: Application of the Wolcott (1994) strategies to ensure trustworthiness of the research

Wolcott Strategies (Wolcott, 1994)		**Description**
i.	**Talk a little, listen a lot**	This strategy was applied while conducting the interview. The researcher patiently wait for the responses especially for the interviews that were conducted in English. While waiting, the researcher also tried to think of some other

		probing questions instead of giving any hints that might influence their responses.
ii.	**Record accurately**	This strategy was applied while conducting the interview and observation in the class. Though the interviews were fully tape-recorded, the researcher still jotted down some important responses from the interviewees. While it was nearly impossible to record all events in the class during the observations, it was important to record observation on field notes as soon as possible to capture accurately the essence of what took place.
iii.	**Begin writing early**	This strategy was applied while conducting the observations. The reflection part of the field note were written right after the class dismissed. This action revealed what questions need to be asked in the next day or how to focus the observation (Gay et al, 2009)
iv.	**Report fully**	Reporting all kinds of data including discrepant data or data which was unfavourable to research aims. It might be helpful to reflect and seek further explanation about what was actually happening in the setting.
v.	**Seeking feedback**	Seeking feedback from various type of people involved in the research such as colleagues and university administrators was essential to get insights into what the researcher may have taken for granted. In this study, the researcher was continuously getting feedback from local practitioners as well as students during the implementation periods.
vi.	**Write accurately**	Since the researcher is a non-native English speaker, examine the language in the written account was important to determine the clarity of the communication patterns. This was achieved by using English proof-reading services.

As mentioned in the earlier part of this chapter, the research has adopted a variety of data collection methods and sources to enable the research be viewed from different perspectives. Field notes were recorded during and after the class; students written reflection were administered after each of the PBL problems; and surveys and interviews were conducted at the conclusion of the semesters. The

students have generated artefacts such as layout of the laboratory, evaluation tools and articles, all of which have been analysed to enhance the data analysis and interpretations. This strategy led to the triangulation of the data, in which themes from interview transcripts, field notes and written reflections were compared to identify general patterns of similarities, points of clarifications and contradictions. The multiple qualitative data collection strategies and data sources adopted in the study have led to a comprehensive view of the interacting variables. This allowed the strength of one particular strategy to compensate for the weakness of another. Though the approach used were mainly qualitative and interpretive, the quantitative-type data from the questionnaire has supplemented the qualitative information to describe the data.

2.6 Conclusions

The aims of the PBL implementation was not merely for a one shot study, but to be sustained in the practice and be suited with the contextual needs, norms and ethos. A new research methodology is therefore, needed to design such PBL approach. DBR has been identified to address the need of developing PBL designs that able to address contextual need and maintained rigour of educational research. Accordingly, the research is divided into three design phase: *Compiling Initial Findings for PBL Design* which aimed to provide initial findings that served as a foundation to develop the PBL designs; *Developing the PBL Designs for Malaysia Setting*, which aimed to develop a PBL design for the Malaysian teacher education context; and *Implementing the PBL Designs in Malaysia Setting*, which aimed to enact the PBL designs in the Malaysian teacher education context. The research has employed a variety of data collection methods such as literature reviews, interviews, students' written reflection, observations and questionnaire within this three design phases. As for the qualitative data, the inductive analytical approach was used to analyse the data. The inductive analytical approach strived to develop common themes from various qualitative data sources, which in turn, would be aligned with the DBR as a methodology that aimed to develop and contribute to the theory. As for the quantitative data, descriptive analysis was used to determine the central tendency such as frequency, mean, and standard deviation using SPSS. Quantitative data served as a complement to the qualitative data and represent responses from all the students. As a qualitative-oriented research, issues of rigour and trustworthiness were attended by adopting Wolcott (1994) strategy of; talk a little and listen a lot, record accurately, begin writing early, report fully, seeking feedback and write accurately.

CHAPTER 3

PBL DESIGN DEVELOPMENT AND IMPLEMENTATION

3.1 Introduction

This chapter presents the three design phases to describe how the design and iteration activity was carried out. The design phases were derived from the DBR methodology that generally involved design, implementation and evaluation of innovative designs. In this research, the design phase was translated into (1) compiling initial findings for the PBL design, (2) developing the PBL design and (3) implementing the PBL design in Malaysian teacher education. This chapter begins with an overview of each design phase in order to inform the elements/sub-phase involved; it is followed by detail descriptions on activities and consideration involved in each design phase. This chapter also describes how each design phase relates to another in order to form a scientific discourse on design and implementation activities of the PBL designs.

3.2 Overview of the Design Phase

This research is spread across three design phases, where each phase consisted of a few elements/sub-phases, as shown in Table 12:

Table 12: Elements/sub-phases in the three design phases

Design phase	Elements/sub-phases
Phase 1: Compiling initial findings for the PBL design	• Theoretical element • Practical element • Contextual element
Phase 2: Developing the PBL designs for Malaysia setting	• Initial findings for PBL design • Elements of PBL curriculum • Analysis of the course
Phase 3: Implementing the PBL designs in Malaysia setting	• Pre-implementation • Implementation • Reflection on the implementation

As the name suggests, the first design phase aimed to report the initial findings for the PBL design development for use in the second phase. With DBR as the research framework, the initial findings were derived from theoretical, practical and contextual elements (Kolmos, 2013). Interconnections between these elements served as the foundation to develop the PBL designs. The *theoretical element* was contributed by the literature review, in which sources relevant to the research, and issues specific to the current research interest were identified. The *practical element* gave insights on how PBL are being practiced. In this research, the Aalborg University (AAU) case on project-oriented PBL contributed to the practical elements of the initial findings. *Contextual element* is the unique feature of the first design phase in which the research context was considered to develop PBL designs that correspond to the local practices and norms. To elicit the information, partnership was established with a local PBL practitioner. These elements interacted, supported and served as the initial findings and foundation for the PBL design development in the second design phase.

The second design phase aimed to develop the PBL designs for the Malaysian settings, which consist of three elements as shown in Table 12. The first elements, the initial findings for PBL design were derived from the first design phase. Awareness on the *elements of PBL curriculum* (second elements) was promoted by Kolmos *et al.* (2009), who mentioned that a variety of

curriculum elements should be aligned in order to achieve a viable PBL design. The third element–*analysis of the course structure*–aims to ascertain how the current course could be redesigned into a PBL design by considering contextual elements and the course content. The interplay between these elements makes the best possible decision by considering the contextual opportunities and challenges in which the design was being constructed. Edelson (2002) remarked that the more informed the researcher/designer in making the decisions, the better the decision will be. Therefore, a concrete and intact PBL designs that consist of the PBL problem scenario, types of assessment, learning conjecture, and facilitation style were expected to be completed at this phase.

The third design phase was the PBL design implementation, which was further divided into three sub-phases; pre-implementation, implementation and reflection on the implementation. *Pre-implementation* phase mainly involved interaction with a local PBL practitioner through meetings and academic discourses. In this phase, the researcher and the local PBL practitioner would achieve a common ground on the learning conjectures (expected sequence of teaching and learning activities) and a plan to support student learning. According to Gravemeijer and Cobb (2006), the learning conjectures should consider how the content are going to be enacted, the nature of the classrooms norms and the nature of the classroom discourse. The support for student learning additionally, consisted of potentially productive instructional activities and tools as well as envisioned classroom culture and teacher's role.

Implementation phase involves systematically adjusting and iterating the various aspect of the PBL design so that each adjustment serves a type of experimentation that allows the researcher to test and generate theory in naturalistic contexts (Brown, 1992). The main aim of the PBL design implementation was to continuously refine the PBL designs by following new revelation as the research progressed. Therefore, the implementation processes was highly documented, mostly involving formative evaluation, and a variety of data collection techniques. How the change was sustained and become part of the pedagogical practice in local institutions was also assessed.

Reflection on the implementation involves reflecting the implementation process to explicitly report on the changes made on the PBL designs along the implementation process. This process involved converging between design, theory and practice, which lead to the development of local design principles and theories that are (1) accountable to the design activity, (2) dealing with the learning process locally usable knowledge, and (3) dealing with the results that speak directly to the designs about teaching and learning activities, materials and systems. The following section discusses the three design phases in detail.

3.3 Phase 1: Compiling Initial Findings for the PBL Designs

Initial findings for PBL design were compiled to guide the development of the PBL designs in the second phase of this study. This was part of an effort to develop a PBL design that is contextually-based and flexible, yet consistent with the important principles of learning. In DBR, the design of a specific teaching and learning approach should be able to link theory to practice (Reimann, 2011). Achieving that required the initial findings to include both theoretical and practical elements. Since the wide scope of processes and context were considered relevant in DBR (Confrey, 2006, p.135), addressing the contextual challenges in the initial findings was also essential. Therefore, theoretical, practical and contextual elements were considered in compiling the initial findings for PBL designs, as showed in Figure 2.

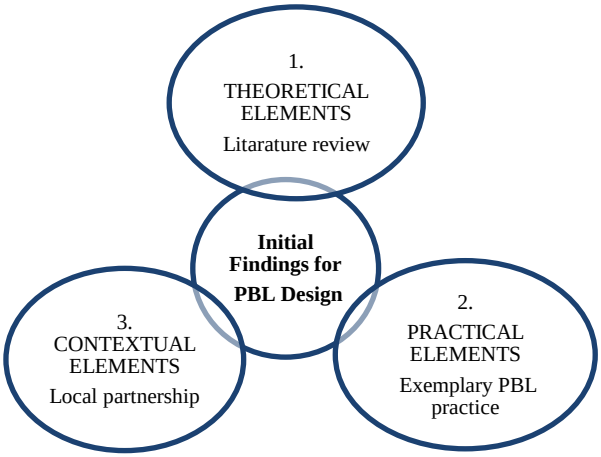

Figure 2: Three elements involved in compiling the initial findings for the PBL designs

These three elements interact, influence and even intertwined with each other; they serve as a foundation to develop a theoretically-sound, and contextually-sensitive PBL design in the second design phase. To support the initial findings with the *theoretical elements* (first element) from the outset, a literature review was conducted to identify sources relevant to the research, and topic or issues which are specific to current research interest. In this research, the literature review was focused on two fields of PBL implementation; in Malaysia higher education and in teacher education.

It was equally important to include *practical elements* (second element) to create a concrete mind-set of how a new curriculum practice such as PBL can be implemented (Kolmos, 2014). In this research, the practical element was obtained from a PBL case at Aalborg University (AAU), Denmark. The AAU case was chosen for its unique approach of combining project and problem-based curricula to its entire academic programmes. As an exemplary PBL model, the project-driven PBL model integrates PBL into project-based learning, with a substantial focus on project activities throughout the curriculum (Kolmos, 1996).

The third element in the initial findings was to address the *contextual elements* of the local settings. To elicit such information, partnership with a local PBL practitioner was established to ascertain how much freedom were allowed in the curriculum, and to ensure the feasibility of the initial PBL designs. The local PBL practitioner involved in this study was an academic staff in UPSI who implements PBL in her course. Apparently, she knows more about the complexity of the culture, objective, mission and vision and operating educational intervention. A researcher/designer on the hand, is often well-trained to conduct rigorous educational research. Hence, it is imperative that both parties collaborate to develop the PBL designs in order of its effect to take place in the local context. The following section describes how these three elements contribute to the initial findings for the PBL design.

3.3.1 Theoretical Element

Literature review helps to flesh out what is known about a problem and guide on the development of potential solutions. In addition, it provides the understanding of the important processes and variables and how PBL affect students' learning and learning environment. Since the PBL designs will be implemented in Malaysia teacher education field, it is important to get an insight into the arising issues on PBL implementation in Malaysia, and how does the practice impact learning in teacher education. As far as the researcher could determine, no PBL review that has specifically been focused either on Malaysian higher education or in teacher education. Previous review work on PBL focuses in the medical education (for example see Albanese and Mitchell (1993), Colliver (2000) and Norman and Schmidt (2000). In this research, the literature review was reported in the form of two journal articles. Article 1 (see *Appendix I* for full paper) is a review paper that focuses on the learners' experience and issues of PBL implementation in Malaysian higher education.

Regardless of field, Article 1 also aims to put forward how PBL affects student learning and issues of PBL implementation in Malaysia. The findings of the reviews are summarised in the following Table 13.

Table 13: Research findings on student learning experience and implementation issues of PBL in Malaysian higher education

Article 1	
Title	**Problem Based Learning (PBL) in Malaysian Higher Education Context:** **A Review of Research on Learners´ Experience and Issues of Implementation**
Research findings	**i. Impact of PBL on student learning:** • Fosters in-depth understanding • Develop group interaction skills • Positive attitudes towards learning • Positive effect on students' motivation levels • Increased skills in problem solving, self-directed learning team-work and self-confidence • Improved ability to think critically and the ability to function well as team **ii. Issues of PBL implementation in Malaysian higher education:** a. Prior to PBL implementation • Support to implement PBL • Preparing academic staff for the new roles • Preparing students for active learning roles b. During PBL implementation • Ways of introducing PBL • Facilitations style • Involvements of students in group discussions

Regardless of the discipline boundaries, Malaysian higher education students in a PBL learning environment are aware of the skills they archived in PBL, such as the skills of social interaction, problem solving, self-directed, critical thinking, and team working. Apart from skill acquisitions, PBL also fosters in-depth understanding, enhances theoretical knowledge, and promotes deep approach to learning. Group working in PBL is seen as a way for students to actively participate in

a learning process, hone their skills to seek for relevant information, enhance cooperation and trust among peers in a group, and inculcate their ability to function well as a team. Strong support from staff and faculty, and students and teachers' readiness appear to be the key ingredients for successful implementation of PBL in Malaysia.

Article 2 (see *Appendix J* for full article) on the other hand, is a review article that specifically focuses on the impact of PBL on pre-service teachers´ learning. By reflecting on the cumulative empirical evidence on how PBL impact pre-service teachers´ learning holds the potential to refine its employment, and contemplate any rooms of improvement. This will subsequently lead to an improved constructivist learning experience for pre-service teachers. The findings of the reviews are summarised in Table 14 as follows.

Table 14: Research findings on the impact of PBL on pre-service teachers´ learning

Article 2		
Title	**A Review of the Impact of PBL on Pre-Service Teachers' Learning**	
Research findings	**i.**	**Impact of PBL on pre-service teachers' knowledge:**
	•	Develop knowledge base and pedagogical reasoning that correspond to current belief in primary teaching and student learning
	•	Substantial understanding of pedagogical knowledge about PBL, despite reporting of having difficulty to crafting authentic and ill-structured problems
	•	Expand knowledge about factors influence child development.
	•	Knowledge is constructed because PBL require substantial mental processes that lead to meaningful discussion
	•	Able to cover broader perspective of factual knowledge within limited class time
	•	Gain insights and knowledge in technology, self- organization and classroom management.
	ii.	**Impact of PBL on pre-service teachers' skills:**
	•	Ability to develop appropriate problem solving strategies skills and understanding in short time.
	•	Better skills in constructing the central problem, elaborate the problem, connection between solution and problem and used of multiple resources.
	•	Develop necessary skills for teachers such as critical thinking, literature searching, self-directed learning and problem solving

	• Develop critical skills, reflective skills and skills needed by teaching professions. • Improve their communication skills, team working and information gathering and selecting and analytical skills • Acquire skills and theoretical content relevant to their future careers within the reflective safety of the university environment

The general aim of PBL implementation in teacher education is to better prepare teachers with many school and classroom issues, such as change in educational policy, technology use in classroom, and school students' diversity. School-based assessment and shift towards outcome-based education–are among the seminal issues that call for teachers to be both knowledgeable and skilful. This review work has clearly showed that PBL has enhanced pre-service teachers' knowledge and skills. The practice also appears to be appropriate for inculcating the skills demanded in the teaching profession such as information processing-related skills, critical thinking skills, self-directed learning skills, problem solving skills and social skills.

Knowledge acquisition is perceived as equally important for pre-service teachers although PBL emphasises more on skills acquisition. The review also revealed that PBL has addressed both pre-service teachers´ Pedagogical content Knowledge (PCK) and conceptual knowledge. Both type of knowledge are important for pre-service teachers to be relevant in their teaching professions. These findings indicated that PBL is one of the most feasible teaching and learning approach in preparing our teachers for today´s schools. The PBL experience within the teacher education has facilitated pre-service teachers' learning, not only at content level, but also at methodological and behavioural level; this is because the practice provides the skills to formulate action teaching and skills. These skills will be required by school teachers when they keep up with many school issues.

3.3.2 Practical Element

To complement theoretical findings in the review works, an Aalborg University (AAU) case on PBL was examined. The case focused on first-year students' learning experience in PBL. These students were chosen to determine how they tackled the challenges in a PBL learning environment, a practice that is new to them. Getting this insights is important because they will inspire the development of the PBL design for the Malaysian setting. Similar to the the first year students in AAU, Malaysian students are also not familiar with PBL. Hence, information elicited from AAU

first year students will inspire the researcher to develop an accurate scaffolding and facilitations strategies for Malaysian students. The AAU PBL case is reported in Article 3 (see *Appendix K* for full article), which focuses on students' learning reported in the group learning strategy, reflection on their learning experiences and how PBL impact their learning. Findings of this article are summarised in the following Table 15.

Table 15: Research findings on the PBL learning experience of the first year AAU students

Article 3	
Title	**Problem Based Learning (PBL): A Context for Collaborative Learning at Aalborg University, Denmark**
Research findings	**i. Group Learning Strategy** • The group learning is started with brainstorming the ideas to get the most feasible ideas from the group members to proceed with the projects. The ideas should be broad yet able to guide the group all the way through the end of the semester. • The chosen ideas underwent series of processes and in-depth discussions to specify it according to the project aims and visions. Students engage in questioning to obtain additional information, hypothesize about underlying causal explanations link with their prior knowledge and perform research that might help to clarify it. The boards that are available in each of the PBL group room are used as a medium to convey and share information with the group members. • In dividing the tasks among the group members, there were two strategies used; based on group members' capability and based on voting. In dividing the tasks based on group member capability, the group assigned the tasks to group members that are most knowledgeable among them in particular tasks. Voting strategy involve random division of tasks to group members without considering knowledge possess among group members. Whichever tasks that they got from the results of voting, the group members deal with the tasks responsibly. Normally students will do the voting strategy at the preliminary weeks of the semester and will use the group member´s

expertise towards the end of the semester if they feel that the group project do not meet the requirements.

- The use of different project management tools to help them manage the group projects. The project management tool may include, group written agreements, timetable and group strategies.

ii. Students´ Reflection on PBL Learning

Students were all aware that they need to improvise their group learning process as this is the key to a success PBL group learning. In particular, students´ reflection on collaborative group learning is divided into three sub-theme; timetable, group members and group learning process:

- In planning the group activities, students in AAU are encourage to use the timetable and it is rely upon the groups on how to plan their timetable. Reflecting on their group timetable, students realize their timetable should not only consist of project work planning, but also should include assignments from the courses.
- Student remarked that better relationships among the group members would enhance group discussions since the group members become more tolerable, open to criticism and gain mutual trusts.
- Planning a day earlier on the tasks that the group should executed will make group members conscious, prepared, motivated and have better mental readiness. With regards to the group discussions, a student confessed that his group should emphasize more on the quality of the content of the discussions.

iii. Impact of PBL on Student Learning

The impact of PBL on student learning can be classified into three sub-themes; skills acquisition, peer learning and meaningful learning:

- Students were aware about the skills they gained throughout the semester such as communication and problem solving.
- During the discussion, students realized that they mutually learn from each other. The mutual learning occur when student learnt from each other and correcting the mistakes of other group members
- By linking what they have learnt from the group learning to other context

	or in daily life, students found that their learning is more significant and meaningful. The knowledge that developed helped students to achieve group goals for learning, and thus, was collectively owned by group members.

In the AAU's PBL programme, the first year undergraduate studies are devoted for students to get accustomed with the PBL ways of learning. This article explores the students' learning experiences in AAU PBL learning environment that focuses on group strategies, reflection and impact of learning. Apparently, the group strategies employed include social learning that involves ideas' brainstorming, equal division of tasks among group members and application of a project management tool. From their reflections, several areas were identified to require improvement: planning for a more specific time table, enhancing rapport group members and emphasizing on the quality of the discussions. The PBL has impacted the students' learning by harnessing their skills, allowing them to learn from group members and offering a meaningful learning experience.

3.3.3 Contextual Element

The contextual elements were contributed by establishing partnerships with a local PBL practitioner and by collaborating with PhD colleagues. The partnerships began at the early stage of the research to comply with the DBR principles that emphasises on contextual consideration at the beginning of the research phase. Close collaboration between both parties is essential in order to understand the contextual possibilities and constraints such as facilities, management support, current students' cognitive level, university's vision and aim, and community of practice. These contextual issues can either serve as affordances or barriers to the PBL design implementation. Design-Based Research Collective (2003) highlighted that partnerships between researcher/designer and local practitioners will yield a design that is able to:

i. Address emerging local issues in efficient and timely manner
ii. Define constraints of the local setting
iii. Highlight participant concern

Since the researcher was in Denmark while the local PBL practitioner was in Malaysia, the partnership was made possible through emails and *Skype*. After several ongoing online discourses, both parties obtained insights on the following contextual elements:

i. Students had different levels of PBL or student-centred experience; some had minimal exposure to student-centred learning like cooperative and group work; some had no experience with PBL at all, and some have experienced PBL in their previous semesters.
ii. The class would be held in a considerably big tutorial room. The chairs were movable with a small table attached to it
iii. Good internet connection was available in the tutorial room
iv. Students normally brought their laptops in the class
v. Most students were part-time students

Another way to address the contextual elements is to learn from other Asian nations which also wish to implement PBL in their institutions. Accordingly, collaboration has been established with PhD colleagues who share the same vision of implementing PBL in their home institutions in India and Thailand. To compare common contextual challenges, possibilities and drivers between the three Asian nation (Malaysia, India and Thailand), Article 4 (see *Appendix L* for full article) was written. The collaboration gave insights on more general concerns with regards to PBL implementation from contextual perspectives. Table 16 summarizes these findings.

Table 16: Research findings on the contextual elements

Article 4	
Title	**Addressing Contextual Elements and Developing Initial PBL Design: Lesson Learned from Three Asian Universities**
Research findings	**i. Administrative system and supports** Obtained support from the university administrative due to the change of policy towards Outcome-Based Education (OBE). PBL is one of the teaching and learning strategy recommended to achieve the OBE **ii. Motivation for PBL implementation** The main motivation is to improve students' competencies profile and policy towards student-centred learning in higher education has provided an extrinsic motivation to adapt PBL in its higher education **iii. Curriculum or course structure**

In the process of redesigning a PBL course, reallocating time for PBL lessons or activities within the existing course structure is applicable. The educational setting of Malaysia allow some flexibility in rearranging and modifying the content of the (PBL) course to be learned. Despite it appear to have a rigid course structure to some extent, within that rigid structure there is a room to integrate PBL at different levels. This is the challenge for both designer/researcher and teacher to be creative in their decision making.

iv. Teaching and learning culture

Malaysian education systems appear to give importance to grade because it is viewed as the measurement of students' achievement and quality. In contrast to PBL approach to learning, education values, plays a crucial role in learning process, not product. Implementing PBL is not about only understanding the concept, but it is about how to actually put the understanding of concept into the actual practice

v. Resources and Facilities

In the PBL environment, lecture room, tutorial room and group room, is the major required space for teaching and learning to take place. Though UPSI are well-equipped with lecture and tutorial rooms, it is not designed for PBL learning environment. The issue of learning space could be resolved by effective and innovative use of available space. For example, space or small rooms could be reserved at the library, or reading hall for group work.

vi. Student Background

Current Malaysian university students have a minimum of 11 years of traditional schooling at primary and secondary level and knowledge is acquired by transmission. Teachers are expected to be the sole provider of knowledge while students are expected to reproduce the transmitted knowledge. Knowledge construction is definitely beyond their comfort zone**.** Exam-oriented, grade-emphasis school system is less favourable to deep understanding and skill development as demanded in PBL. With regard to their previous schooling background, it is important to prepare

our students before embarking on PBL practice

vii. Facilitation Style

To offset the shortage of facilitators, floating tutor to facilitate students learning is employed in Malaysian context. The facilitator will go around the groups to facilitate group work, and probing students´ group with questions that lead students activating their prior knowledge and experiences. Each group is also required to keep group´s logbook and reflection notes to monitor periodically their progression and to determine further scaffolding needed by each group.

The findings concluded that while it might be easy to tackle common contextual constraints and drivers, the specific ones should be attended carefully to minimize tensions from shifting towards an innovative learning practice. The different educational cultures (administration and resources, curriculum setting and teaching learning etc.) were used to inspire the development of PBL designs in the design phase. Contextual elements of the institute i.e. administration, staff, students, curriculum, teaching learning practice and resources were aligned with the PBL approach for change of practice to take effect. It also showed in the above article´s summary that despite the challenges or barriers, possibilities are still there to implement PBL designs.

3.3.4 Initial Findings for PBL Design

The findings from the first design phase were compiled as initial findings for use in the second design phase. As shown in Table 17, the initial findings were based on *student learning*, *potentials* and *constraints.* Aligned with the DBR as a research methodology, these initial findings were obtained from various perspectives since the beginning of the design activity, which consisted of *theory*, *practice* and *context*.

The theoretical elements were obtained from reviewing the works on PBL implementation in two areas; PBL implementation in Malaysia and PBL implementation in teacher education. The practical elements were obtained from an AAU PBL case while the contextual elements were gathered from the partnership with a local PBL practitioner and PhD colleagues. These elements contributed differently to the initial findings. For example, findings on *student learning* were obtained from theoretical and practical element; findings on *possibilities* were obtained from all

three elements while findings on *constraints* were obtained from theoretical and contextual elements. Positioning the initial findings from *theory*, *practice* and *context* have broaden the researcher's perspective in developing the PBL designs in the second design phase.

Table 17: Initial findings for PBL design

Initial findings	Elements of initial findings		
	Theory	**Practice**	**Context**
Student Learning	• In-depth understanding • Group management related skills • Positive attitude • Positive motivation • Self-directed learning • Pedagogical knowledge and reasoning skills for teachers	• Peer learning • Communication and problem solving skills • Ownership of learning • Organized learning	
Potential	• Gradual implementation of PBL • Comprehensive plan for facilitation • Flexibility in rearranging and modifying the course content	• Project management tool to facilitate group learning process • Group learning strategy • Emphasize on the reflection to create awareness in learning	• Manipulating existing facilities to create PBL learning environment • Good internet connection • Support from the management and policy
Constraints	• Passive participation in group learning • Preparing students and academic staff • Facilities that only accommodate for lecturing		• Most of the students are part-timers • Students are more familiar with teacher-centred learning • Students have different level of

			exposure to student-centred learning
Potential	• Gradual implementation of PBL • Comprehensive plan for facilitation • Flexibility in rearranging and modifying the course content	• Project management tool to facilitate group learning process • Group learning strategy • Emphasize on the reflection to create awareness in learning	• Manipulating existing facilities to create PBL learning environment • Good internet connection • Support from the management and policy

On *student learning*, both theoretical and practical elements have indicated PBL's favourable impact on the element; this implied that the practice will be a successful approach in both Malaysian higher education and in teacher education. Despite being more familiar with the conventional way of learning, the Malaysian higher education students were relatively adaptable to the PBL approach, and they were aware of the skills and competencies they possessed after participating in a PBL environment. On teacher education, the findings have also reported on the acquisition of pedagogical skills among pre-service teachers, proving that PBL is suitable for teacher education. From a practical point of view, the researcher was stepping in the best PBL practice at Aalborg University (AAU), which provides first-hand experience on students' learning process. Likewise, the students in AAU remarked that the PBL learning has inculcated skills, ownership of learning and more organized learning.

The initial findings on *potentials* have provided drivers and opportunities for PBL designs' development and implementation. The theoretical elements suggested that PBL be implemented gradually to minimize the tensions among students; also implied was for a comprehensive facilitation plan to be determined. From practical elements, the best PBL practice in AAU has demonstrated that the use of project management tool has been effective in assisting group learning; reflection on learning is also an important element in a PBL learning environment for students to be aware of their learning progress. The contextual elements have offered insights on the possibilities to manipulate university facilities in order to create a conducive PBL learning environment.

On *constraints*, the findings suggested some barriers or challenges for the researcher to heed when implementing the PBL designs. Theoretically, these constraints were often issues of meager participation in group learning, which have sparked the students and academic staff's concern about facilities that might not be conducive for PBL learning. Likewise, the contextual elements have also indicated similar constraints whereby the students were more familiar with student-centred learning. Collectively, two issues need to be addressed when developing and implementing PBL designs: (1) preparing students before embarking on the new practice and (2) utilization of the existing facilities.

The characterisation of *student learning, potential* and *constraints* have laid out the PBL design within which the researcher must weigh the tradeoffs and select alternatives for PBL design development in the second design phase. It may be difficult to develop the design based on this initial finding, which is not all explicit and tangible; the design has also not stepped into the actual practice/implementation yet. Nevertheless, the compiled initial findings would be considered in developing and implementing the PBL design in the second and third design phases. As Edelson (2002) argued, the decision to use these initial findings might not be all explicit, conscious or formally articulated.

3.4 Phase 2: Developing the PBL Design for Malaysian Setting

The second design phase was the process of developing the PBL design for the Malaysian setting, particularly for a science teacher education course. The design process took place mostly at Aalborg University (AAU) with the co-operation between the supervisor in Aalborg, co-supervisor cum local PBL practitioner in Malaysia, and PhD colleagues who were also involved in designing the PBL curriculum for their home institutions in Thailand and India. The supervisors monitored the overall design process, the local PBL practitioner provided information on the contextual elements, while the PhD colleagues provided thoughtful and rigorous discussions on Asian higher education common practices that might serve as affordances or barriers in the PBL design implementation. In designing the course into PBL, it was essential to address the contextual elements that include the cultural dimensions of an institution's policies, aspirations, vision, ethos and values. Therefore, the PBL design was decided based on the need to balance goals and constraints.

As Edelson (2002) posited, a design development can be enormously complex, requiring a wide range of expertise and a systematic process to ensure that goals are met and constraints are observed. DBR attends these issues by emphasising the link between design theory and practice, in the effort to retain PBL theories and principles while at the same time, address the contextual elements and student learning. As a result, the developed PBL design was theoretically grounded and co-constructed in real-world contexts. To achieve such traits, the designs had to take a point of departure from previous research findings–a task accomplished in the first design phase. To ensure that the course was thoroughly transformed into the PBL design, each element in the curriculum should be aligned with the PBL principles, and the current course should be analysed to ensure that goals and learning outcomes are met during the design activities. Hence, three elements were involved in the study's development phase, as shown in Figure 3.

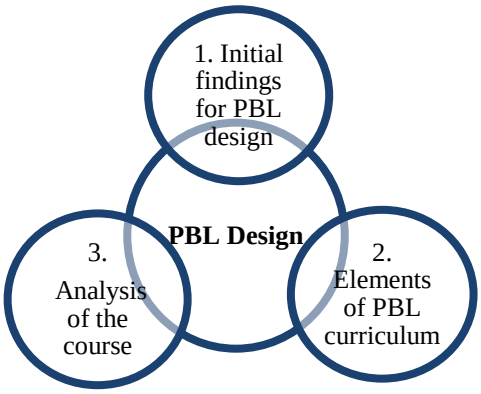

Figure 3: Three elements involved in developing the PBL designs

The first element–the *initial findings for PBL design*–serves as the foundation in the PBL design. The second element–the *elements of PBL curriculum*–was inspired by Kolmos *et al.*'s (2009) work, which recommended that a number of curriculum elements be aligned in order to achieve a viable PBL design. The third element–the *analyses of the course structure*– involved aligning the course outline and the learning outcome with the PBL approach. The first element has been discussed substantially in the previous section; hence, the following section summarises the first element as derived from the first design phase, and followed by the discussion on the second and third elements of the PBL designs.

3.4.1 Initial Findings for PBL Designs

Design activity is a sequence of decisions made to balance goals and constraints. For innovative design such as the PBL, the decision can be complex, requiring extensive investigation, experimentation and iterative refinement to acquire substantial new understanding on student learning (Edelson, 2002). Specific to this research, the initial findings contained preliminary hunch that were elaborated by combining the analysis of the course, and the empirical process during the implementation and evaluation. The compiled findings were then used to develop the PBL designs by striving to address possibilities, satisfy constraints, exploit opportunities and balance tradeoffs. Table 18 exemplifies how this process were carried out:

Table 18: Contemplating on the initial findings for PBL design development

Compilation of initial findings	**Decision for PBL design development**
Gradual implementation of PBL to students	Determine explicit PBL learning process conjectures that considers the interplay between facilitation and student active participation
Passive participation of students in group learning and unfamiliarity with student-centred learning	Allocate a session to introduce PBL to students and facilitation that aims to comply with students need. Perhaps more facilitation is needed for the preliminary weeks of PBL design implementation
Project management tool and group learning strategy	Develop an explicit learning tool to assists students manage their group discussions
Students are part-timers and stay far from the university	The PBL learning process should emphasize on the tasks division among group members. This is vital since it most unlikely that group members would meet beyond class time
Facilities that design for conventional and lecture learning	Manipulation of learning spaces available to create a conducive PBL learning environment

Good connectivity with internet	The PBL learning process should emphasize on searching for resources on reliable databases available on internet

This array of decisions, which derived from compiling the initial findings, was addressed in the PBL design development. However, they should not be perceived as having direct connection with the PBL designs because such decision can lead to both tangible and non-tangible results. For example, the decision might highly influence the learning process conjecture which was not necessarily concrete and tangible. In contrast, it could also influence the design's tangible products such as tools, the PBL scenario and handout for students. Above all, these decisions were correct at the time it was decided and it was subjected to change as the research proceeds.

3.4.2 Elements of PBL Curriculum

Kolmos *et al.* (2009) suggested that the shift towards a PBL approach does not only involve change in teaching methods, but also in the combination of learning methodologies, ways of knowledge construction and the scientific approach to understanding. The authors further identified seven elements in a curriculum that had to be aligned in a PBL design development, as shown in Figure 4.

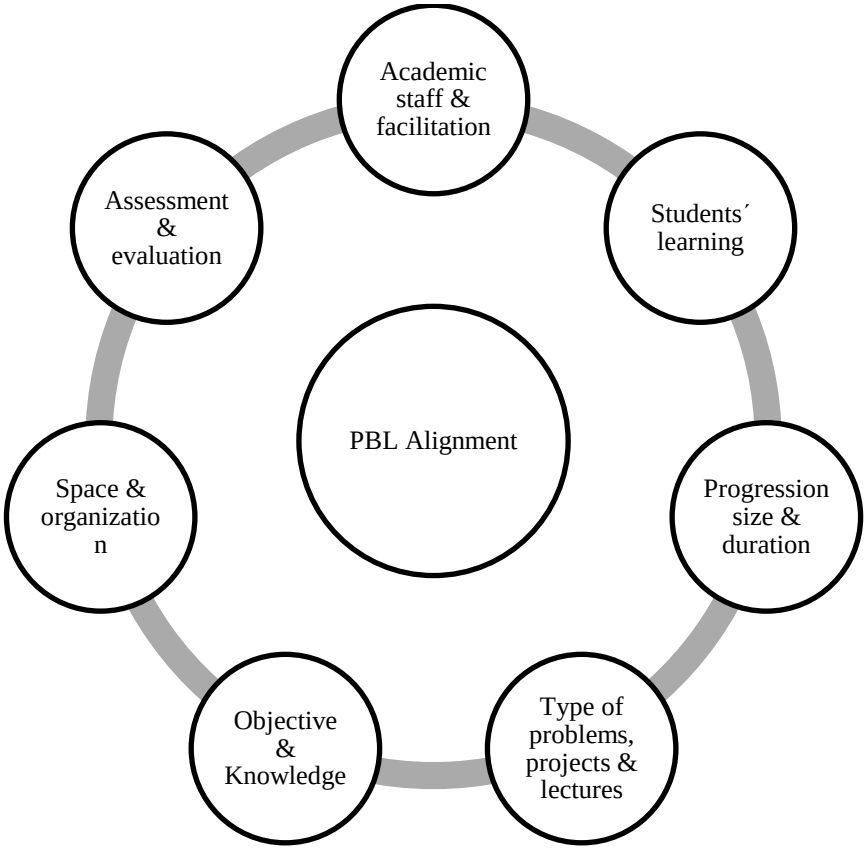

Figure 4: Elements of PBL alignment in the curriculum (Kolmos *et al.*, 2009)

The elements represent most (if not all) of the curriculum elements aligned with the DBR views, which emphasises multiple consideration in design activity. Despite being developed for project-oriented PBL at programme level, the alignments and their components still correspond to the PBL at course level. The *objective, knowledge* and learning outcomes of the course should reflect the PBL principles that emphasise on acquiring knowledge and competencies. For *type of problems, projects and lectures*, the problems should be authentic, open-ended, inquiry-based, ill-structured and engaging but at the same time, effectively targeting the intended learning outcomes.

de Graaff and Kolmos (2003) provided a continuum of problem definition between well-defined problems at one end and open, ill-defined problems at the other end. Since this research involves development of the PBL design for a semester-long implementation, a well-defined problem could be introduced at the early semester to minimize tensions among students. Towards the end of the semester, more ill-structured problems could be introduced since the students would be more capable and familiar with the new approach. A well-defined PBL problem might have more hints and cues, and they are more straight-forward and less complex compared to the ill-structured one. It

is equally pertinent to determine the *progression, size and duration* in order to estimate how much time is devoted for PBL activities, which largely depends on the complexity of the problems. From the initial framework, students may need more time at the early stage because PBL is a different approach of learning.

Supporting *students´ learning* is highly important for a successful innovative learning approach, like the PBL. Because the students were minimally exposed to student-centred learning, preparing them to support their learning is vital. Among the things considered were the way the students form the group, their cognitive level, their group rapport, the scaffolding plan to guide them in using new range of skills, the tutorial process and facilitation. Hence, the *assessment and evaluation* should not only be aligned with the learning outcomes, but also be compatible with the PBL process and how it can support student learning.

Academic staff and facilitation is not relevant for this research since the PBL design was planned for a course-level implementations and the academic staff (the researcher and the local PBL practitioner) were all well-trained in PBL. However, for a future larger scale PBL implementation, staff training and facilitation will be essential in order for the academic staff to deal with different issues in PBL like project supervision, facilitation, group conflict and project management.

Space and organisation, on the other hand, is a paramount issue when it comes to implementing PBL in Malaysia. Hierarchical organization of university administration demands support for any change in teaching and learning to take place. Likewise, the researcher obtained continuous support from the university administrator. The learning space to support a PBL environment was still negotiable. Having clearly dictated the possibilities to align different PBL elements with the local settings, the local setting before PBL implementation was compared with the improvement plan for the PBL design implementations, according to the aforementioned elements of alignments as depicted in Table 19.

Table 19: PBL alignments of elements in the curriculum

PBL elements for alignment by Kolmos et al., (2009)	**The course**	
	Prior to PBL implementation	**Improvement plan for PBL design implementation**
Objective, knowledge	Course content highly emphasize on knowledge acquisition	Course content address both knowledge and skills acquisitions
Type of problems, projects and lectures	No problem-based or projects, the course outline are arranged based on disciplines. The course is delivered through lectures	Presentation of the PBL problems to initiate the learning and lectures are only delivered when needed or upon request.
Progression, size and duration	Student is not concern with their learning progression, hence they are not aware of what should be improve in the next class	Emphasize student progression throughout the semester by encouraging reflection on their learning. Student will aware of their strength and weakness and hence well-informed to improve in the next discussion/tutorials
Students´ learning	Individual and passive ways of learning.	Student construct their own knowledge and meaning from collaboration and group work activity
Assessment and evaluation	Emphasize on summative, semester end examination.	Emphasize on formative and on-going assessment
Space and organization	Big tutorial or lecture rooms, and the space is not manipulated to encourage student interaction	Also in a considerably big tutorial room, but with movable chairs and a table attached to it. Therefore, the space and the current facilities are used to create PBL learning environment
Academic staff and facilitations	No training to academic staff	The local practitioner is considered as PBL expert by practice, while the researcher are formally trained with the PBL research

As shown in Table 19, it is apparent that the course prior to PBL implementation was carried out in conventional ways of teaching and learning. Therefore, to achieve change, all of the elements in the curriculum must be included and aligned.

3.4.3 Analysis of the course

Existing Course Background

The selected course–*Managing Learning in Science (SSB6034)*–is a compulsory course for Master of Education (Science Education) in the Universiti Pendidikan Sultan Idris (UPSI). This postgraduate degree is a one-and-half year (full-time) and a two year (part-time) programme. The course was designed to enable students to analyse the management of learning in school science education through the following general learning outcomes:

- Analyse learning theories
- Evaluate learning 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

The course contents include theories of teaching and learning, assessment for learning, student misconception in science, teaching and learning effectiveness and school science laboratory management.

Aligning the course outline and the learning outcomes

According to Reimann (2011), DBR involves holistic perspectives of designing a ´learning environment´ that include tasks, materials, tools, communication and interaction, and means for sequencing and scaffolding. PBL is a "problem first" learning approach whereby the starting point for learning is in the form of realistic and contextualized problems. Unlike traditional curriculum contents which are arranged according to topics, the contents of a PBL curriculum are organized around problems. To ensure that these problems address all the learning outcomes and simultaneously fulfil the course requirements, the traditional course outline has to be rearranged into the new course outline in the form of three PBL problems: *Constructivism, Alternative Conception* and *21st Century Learning*. These problems could be the latest issues in science education, innovation in science classrooms or issues in science classrooms. In general, the

researcher drew on several situations from his own experience as a teacher, educational researcher, and teacher educator. As shown in Table 20, several topics from the existing course were merged to form the three PBL problems.

Table 20: Comparison of the course outline before and after the redesign activity

Course outline prior to PBL		**Improved course outline for PBL approach**
i.	Shift of learning from behaviourism to the cognitive psychology	PBL1: Constructivism
ii.	Best practices in science teaching and learning.	
iii.	The application of constructivist teaching approaches	
iv.	Management of authentic assessments and assessment for learning	PBL2: Alternative Conception
v.	Eliciting student misconceptions	
vi.	Strategies to improve teaching and learning effectiveness	PBL3: 21st Century Learning
vii.	Laboratory management	
viii.	Science learning in the future	

The first PBL problem–*Constructivism*–is centred on principles in classroom teachings. It represents contemporary views of how learners obtain knowledge in learning sciences. In addition, constructivism is a rather general topic which allows students in the current research to interconnect between different student-centered learnings. However, this PBL problem will focus on constructivism's central principles, and its application in classrooms; it also intends to identify constructivism elements from a learning session. The second PBL problem–*Alternative Conception*–focuses on identifying alternative conception in science topics of a school science curriculum. Alternative conceptions are among the seminal issues in science education, which have been substantially discussed in the literature. The third PBL problem–*21st Century Learning*–

focuses on school science laboratory that promotes the 21st century learning principles. Malaysian school science laboratories are designed for group experiments, in which school students in a group will perform a pre-determined experiment procedures. The current laboratory designs are not promoting deep learning and they are neither inculcating skills among school students. This is because they blindly followed experiments procedures from laboratory manuals (for detail discussion of each PBL problems, see part *3.4.4: The PBL Toolkit* in this chapter).

Constructivism, alternative conception and 21st century learning are among the seminal issues discussed in Malaysian science education and in international learning science community. By aligning the course outline into these topics, it was hoped that the students would be engaged in a process that would help them see the interconnection between the main issues raised in science education. Upon identifying the appropriate PBL problems without neglecting the course contents, it was also important to determine and match which learning outcomes can be addressed by which particular PBL problem (now is the course content). These were done by using a curriculum matrix, as shown in Table 21.

Table 21: Curriculum matrix to match the learning outcome to the new course content (PBL problems)

Learning outcomes	**PBL Problem**		
	PBL1: Constructivism	**PBL2: Alternative conception**	**PBL3: 21st century learning**
Knowledge:			
• Identify elements of constructivist teaching practices	√		
• Provide justifications of the constructivist elements identified	√		
• Differentiate constructivist and non-constructivist	√		
• Construct an evaluation tool to evaluate a teaching	√		
• Write a research report on students' alternative conceptions		√	
• Suggest ways to elicit students´ alternative conception		√	
• Propose strategies to overcome students´ alternative conception		√	

• Explain the central tenets of 21st century science learning			√
• Design a layout plan for a 21st century science laboratory			√
• Justify the layout plan for 21st century science laboratory			√
Process and skills:			
• Develop skills in searching for relevant information	√	√	√
• Ability to critically and creatively define the problem	√	√	√
• Acquire team skills through group work	√	√	√
• Demonstrate communication skills through presentation	√		√
• Ability to conduct individual studies based on the tasks given	√	√	√

As shown in the above table, each PBL problem has its own specific knowledge-type learning outcome that students are expected to achieve. The three PBL problems have addressed process and skill-type learning outcome to comply with the PBL principles, which emphasise on skills and competencies. Finally, the PBL problems were adapted, to fit in the new course content by preparing the PBL toolkit.

3.4.4 The PBL Toolkit

The PBL toolkit is an explicit teaching and learning material that will be delivered during the PBL design implementation phase. Since PBL is relatively new to the Malaysian teacher education context, the teaching and learning material should be concrete enough to guide both facilitators and students. Based on the improved course outline and learning outcomes, the PBL problems (PBL1, PBL2 and PBL3) were designed to comprise the following teaching and learning materials.

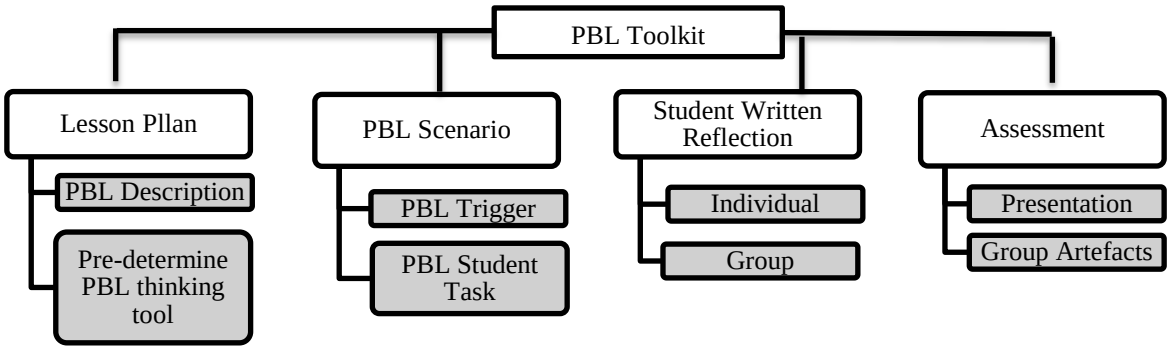

Figure 5: Four components of the PBL toolkit

As shown in Figure 5, the PBL toolkit consists of four teaching and learning materials; *Lesson Plan, PBL Scenario, Student Written Reflection* and *Assessments*. These materials were designed for both facilitators and students. For facilitators, the material may consist of a list of main concepts for discussions, response suggestions to the situations and students, a list of suggested sources, learning conjectures and learning outcomes. For students, the material may include a guide to work in a team, a suggested learning process, tools to deal with the problem scenarios and roles in group discussions. The following paragraphs discuss each of the materials. Details of the PBL toolkit are available in *Appendix* M for PBL1, *Appendix N* for PBL2 and *Appendix O* for PBL3.

Lesson Plan

A lesson plan was developed for facilitators, which consisted of two components*: PBL description* and *pre-determine PBL thinking tool. PBL description* contains the overall plan of a particular PBL problem such as (1) the learning outcomes that students should achieve, (2) estimated weeks to complete the PBL cycles, (3) prior knowledge the students are expected to possess, and (4) the learning conjectures. The *PBL thinking tool* is a four-column table with headings (*Facts, Ideas, Learning Issues* and *Action Plan*) that will be the tool to scaffold a group of students in order to manage the information during PBL group discussions (see Chapter 4, part 4.2.2 for detail discussions of the *PBL thinking tool*). In the *PBL thinking tool*, the group of students will fill in the column with different kind and level of information according to the headings; this serves as the focus for negotiating the PBL problem under scrutiny. To guide the students in filling in the column, the completed *pre-determine PBL thinking tool* is important to help the facilitators to monitor student progressions in group. This is how the facilitators review the students' progress and

equip himself/herself with the data that can be revealed incrementally (progressive disclosure) as the problem scenarios proceed.

PBL scenario

The underlying principles of developing a PBL scenario reflect on how people solve problems in their everyday lives. When people confront a problem, they analyse the situation, identify what the problem is, enquire the information they need to know, and come up with hypotheses and solutions. Since the PBL scenario will be the first tool presented to the students, it must be engaging. For this reason, the PBL scenarios were drawn from real life situations of being a school teacher. Two components build up the PBL scenario; *PBL trigger* and *PBL student task*. *PBL trigger* is a carefully chosen situation/stimulus to activate the group learning process. While it encourage students to work on a specific PBL problem, the *PBL student task* help them to move forward with the *PBL scenario* by exposing initial hints and cues. Table 22 shows both *PBL trigger* and *PBL student task* based on each PBL problems.

Table 22: *PBL trigger* and *PBL student task* according to specific PBL problem

PBL Problem	PBL Trigger	PBL Student task
PBL1: Constructivism	A video of a real classroom showing a primary-school level teacher teaching her pupils on *Body Parts*	An instruction statement
PBL2: Alternative Conception	Sample of pupil´s drawings on their conception of light	An invitation letter from a journal publisher
PBL3: 21st Century Learning	A poster on a competition to design a 21st century learning school science laboratory	

As shown in Table 22, *PBL trigger* and *PBL student task* can take in many forms and media. In PBL1, a 15-minutes duration video of a teaching and learning session in a primary school classroom serves as the *PBL trigger*. While watching this video, students will be encouraged to identify

elements of constructivism in the teaching sessions. This will create self-awareness on their own teaching strategy in a school classroom. To further assist students in dealing with their first PBL problem, the *PBL student task* will be presented to them in the form of instruction statement as shown in Figure 6. This *PBL student task* is quite directive and straightforward. Being the first PBL problem that the student will encounter, deliberately designed in a way that is to guide students to manage their group learning process.

BODY PARTS

Watch the 15-minutes length video of a science teacher teaching about parts of the body in your school. You are requested to do a peer review of the lesson and assess the extent in which teacher Jamilah employed constructivist teaching and learning principles in her lesson. Develop an instrument for the review process and explain the elements that were incorporated in it. Use the instrument developed to assess the lesson and present the results to other science teachers in your department. Suggest improvements on how to improve the lessons.

To facilitate group discussions:

i. Appoint a chairperson and a scribe. A chairperson will steer the discussions by encourage members to participate, ensure scribe can keep up and is making accurate record and keep to time. Scribe will record points made by group and help group order their thoughts. For the rest of group members, follow the steps of the process in sequence, ask open questions, share information with others and actively involves in group activity.

ii. Set the group´s discussion strategy such as: To start the discussion by brainstorming, synthesis and analyses each points, sorting out the information based on learning issues, equal contribution of each group members, strategies to divide the task before leaving the class, and resources to approach.

Figure 6: *PBL student task* in the form of instruction statement for PBL1

The *PBL trigger* for PBL2 is in the form of pupil´s sample drawings on their conception of how the light travels. Students will be suggested to scrutinize on those drawings and differentiate which is according to scientific conception and which is misconception. The *PBL student task*, additionally, will be presented in the form of invitation letter to publish a review article from a journal publisher. In PBL3, both *PBL trigger* and *PBL student tasks* are combined in the form of poster competition. Both *PBL trigger* and *PBL student task* form intact PBL scenarios for students to work on. In this research, the PBL scenarios are not rigidly defined as though there is only one simple and correct

answer. In fact, they were developed in such a way that it relates to several content areas across the curriculum that leads to many solutions. For example, in PBL1, the group of students develops evaluation tools in the form of rubrics or checklists to assess how extensive a teacher in the video has been adopting the constructivism principles in her teaching. Hence, apart from acquiring knowledge on constructivism, the students also apply their knowledge on how to develop evaluation tools.

In PBL2, students perform a research on alternative conception in science learning. To exploit the vast related literature, students will review journal article/conference proceedings on alternative conception in science topics. They are allowed to choose which topic they wish to research according to their background. Therefore in PBL2, students will learn skills to locate relevant and appropriate sources and reflect upon how to tackle the alternative conception among school students. Upon identifying sources, students will review each article and write a review report in the form of reviewed articles. In PBL3, students will perform a design activity whereby they are required to re-design and conceptualize a future school science laboratory according to the 21st Century Learning skills. These students then will learn the concept of 21st Century Learning skills and apply the knowledge by developing a school science laboratory that aims to promote those skills among school students, while they are performing science experiments. In other words, they apply the knowledge they gained by creatively and innovatively design a science laboratory. This approach–crafting the PBL scenarios–assists students in developing a network of ideas and seeing patterns across problems; it also enables them to expand and integrate knowledge from variety of perspective. Each group of students is expected to develop different approaches in dealing with the problem scenarios. They will learn more and expand their perspectives by critiquing and arguing with other group members when presenting their findings. Depending on the number of learning outcomes and difficulties, these students are expected to deal with the tasks in different time frames, probably between two to four weeks.

Student Written Reflection

In this research, *student written reflection* serves three purposes: as a learning tool for students, as one of the data collection technique and as an assessment approach. This section discusses student's written reflection as a learning tool (see part 2.4.3, Chapter 2 for *student written reflection* as the

data collection technique and the following section for discussions of *student written reflection* as an assessment approach). *Student written reflection* serves as a platform for students to note their learning progress by reflecting on their learning process in the PBL groups. In particular, the opportunity for students to reflect on their learning process form an integral aspect of PBL (Holen, 2000). There are two types of *student written reflection* employed in this research; *individual written reflection* and *group written reflection*. *Individual written reflection* requires students to record their thinking about group processing**,** what they have learned, peer evaluation on how individuals contributed to overall effectiveness of the group, roles they took, issues, frustration and difficulties they faced. *Group written reflection* requires students to describe how they start the discussions, strategies to enhance group collaboration, evaluation of the PBL problems, how they address the learning issues, resources used to deal with the tasks, and any prior preparation before attending the discussions. Students' reflection will give insights on how they have been learning through PBL such as dealing with the PBL problem scenarios, the group discussion strategy and conflict handling. This information serves as a valuable resource for the restructuring of the PBL cycles because it provides better facilitation according to the students' learning experiences.

Assessment

In planning the assessment component of the toolkit, emphasis was given on how the assessment corresponds to both the PBL and the learning outcome. Constructive alignment–a term coined by John Biggs (Biggs, 1999)–suggests that learning activities (PBL in this research) and assessment tasks should be aligned with the learning outcome of the course, resulting in a consistent system as shown in Figure 7:

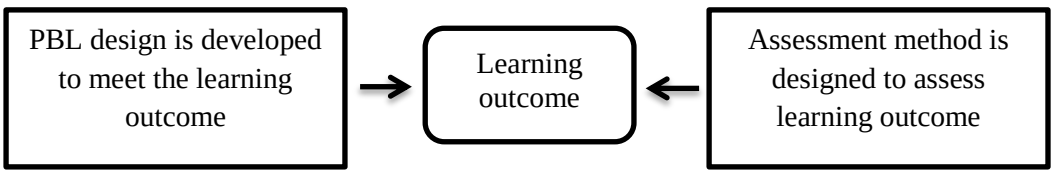

Figure 7: Aligning learning outcome, teaching and learning activities (PBL) and the assessment (adapted from Biggs, 1999)

PBL is distinguished from the conventional teaching and learning by its focus on learning to learn rather than by mastery of certain knowledge (Major, 1999). Likewise, conventional teaching and

learning of assessment may not be suitable to use in alternative teaching and learning approach. This stands to a reason that authentic assessment may be necessary for PBL. According to Nightingale et al., (1996) authentic assessment is defined as *"assessing range of knowledge, skills and attitudes in the one assessment task".* In this research, authentic assessment was divided into two: group assessment and individual assessment, as shown in Table 23:

Table 23: Authentic assessment according to the PBL problems

Authentic assessment	PBL Problem	Assessment tasks	Marks allocated (in%)
Group Assessment	i.) PBL1: Constructivism	• Constructivism evaluation tools • Presentation • Group written reflection	25
	ii.) PBL2: Alternative Conception	• Journal article • Group written reflection	25
	iii.) PBL3: 21st Century Learning	• Layout plan of 21st Century Lab • Presentation • Group written reflection	25
Individual Assessment	• Individual written reflection for PBL1, PBL2 and PBL3 • Attendance and Participation		25

For grading purposes, emphasis is given to the *group assessment* that represents two third of the overall marks. These marks are equally divided between three PBL problems and they are further divided within specific PBL problems according to task. For example, in PBL1, the 25% marks are further divided into 10% for *constructivism evaluation tool*, 10% from *group presentation* and 5% for *group written reflection.* As the name implies, each member of the group receives the same marks for group assessment. This is a strategy to ensure that students really collaborate and strive to complete their group assessment tasks.

Another one third of the marks was allocated for *individual assessments,* which assess through three *individual written reflection* and *attendance and participation.* These components are assessed

based on students´ contribution–and active participation–in group. Incentives or rewards to students on their participation and attendance will boost their motivation and retain their commitments especially in a new learning environment, where the students may have more tendencies to give up since they are not familiar with it. As PBL emphasises on learning process, skills and competencies' developments, the assessment should be able to measure these performances, as established in the learning outcomes. According to Wood (2003), the PBL assessment should include assessing the generic skills and competencies in terms of teamwork, chairing the group, cooperation, respect of colleague´s views, use of resources, and presentation skills. Table 24 exemplifies how skills and competencies are addressed in the learning outcomes.

Table 24: Examples of skills and competencies and ways to assess

Skills and competencies	Learning outcome to be measured	Assessment task	Assessment tool
i. Communication	Demonstrate communication skills through presentation (PBL1 & PBL3)	• Presentation of the evaluation tool • Presentation of the 21st century laboratory layout plan	Rubric to assess group presentation
ii. Creativity	Design a layout plan for 21st science laboratory (PBL3)	A science laboratory layout plan for 21st century learning skills	Rubric to evaluate laboratory layout plan for 21st century learning skills
iii. Critical and creative thinking skills	Ability to critically and creatively define what the problem is (PBL1, PBL2 & PBL3)	The PBL thinking tool	Pre-determine PBL thinking tool

As shown in Table 24, skills and competencies are clearly spelled out in the learning outcome to provide an explicit focus to both facilitators and students on what they must achieve at the end of a PBL problem. Assessment tasks such as group presentations and group deliverables were designed to create opportunities for students to develop those skills and competencies. For facilitators, assessment tools such as rubrics were used to determine to which extent the students have achieved those skills and competencies. These assessment tools (e.g.: rubric for oral presentation, rubric to evaluate journal articles) are given to the students prior to the assessment so that they are aware of

the criteria against which their performances are measured. This practice encourages students to self-assess, thus, improving the quality of their work.

Student Guide to PBL

PBL learning environment use problems as the starting point for learning and this represents a significant shift in learning for most of the students. Though some of the students had prior experiences of working in groups or even in a PBL environment, most were not familiar with student-centred, active learning strategies. Changing to PBL also involved changing the students' role as well. Instead of passively receiving information disseminated by the lecturers, the students were demanded to actively construct knowledge and analyze problems by using relevant resources, contemplate on a variety of possibilities, and finally propose the most feasible solutions. In addition, the PBL learning process is rather unusual and contradicts the way they learned before. Students who are new to this practice require significant instructional scaffolding to support the development of various skills demanded in PBL. This research use variety of strategies to support student learning in PBL.

Lack of previous experience in group learning among students is anticipated by developing a guide called *Student Guide to PBL* (see *Appendix P* for *Student Guide to PBL* handout) for students to get familiar with the PBL approach. The Guide contains introduction to PBL, characteristics of PBL, rationale for learning through PBL, depiction of PBL processes, proposed steps to approach the problems, roles responsibilities of the group members, expectations on the learning and a walk through a sample PBL scenario as an introduction to the PBL process. This was necessary because it should not be assumed that the students are naturally skilled in group collaborations and handling PBL scenarios of open ended problems.

3.5 Phase 3. Implementing the PBL Design in Malaysian Setting

Once prepared, the PBL design implementation phase commenced. This section reports on the actual events during the implementation that took place at Universiti Pendidikan Sultan Idris (UPSI), Malaysia. The implementation phase emphasizes on the feasibility of the PBL designs while simultaneously develops an understanding on how theoretical goals could be achieved by the PBL designs implementation process. In a DBR research, this is one of the core challenges because

the findings were recognized as an interaction between design and enactment, and between the general and local. It is worth noting that the PBL designs developed in the second design phase is not followed exactly how it was designed; rather it is subject to change if accumulated evidences and specific circumstances lead the researcher to believing changes are necessary. Therefore, the PBL design proceeded through iterative cycles of design and implementation, by using each implementation cycle as an opportunity to collect data for the subsequent design cycle. To do so, the implementation phase was further divided into three sub-phases: *Pre-implementation*, *Implementation* and *Reflection on the Implementation*, as shown in Figure 8.

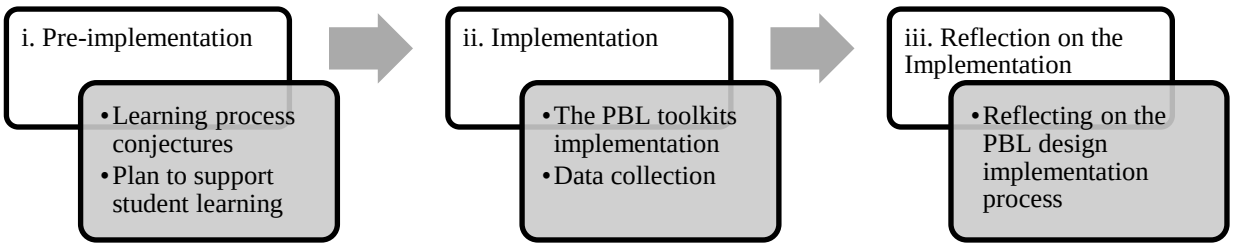

Figure 8: Sub-phases and main activities involve in the implementation phase

3.5.1 Pre-implementation phase

Prior to implementation, it was important for the researcher to physically interact and discuss with the local PBL practitioner to finalize how the PBL design will be executed. At this stage, the researcher was already at UPSI–three weeks before the semester commences. Although a series of online discourse were already carried out and the PBL designs were already in place, the real picture on how the PBL designs will be executed could only be grasped when the researcher is in the context i.e. Malaysian teacher education context (UPSI). Therefore, before the semester commenced, the conjectures about possible learning process and means to support it should be ascertained. Likewise, Gravemeijer and Cobb (2006) suggested that the conjectures should consider how the content are going to be enacted, the nature of the classrooms norms, discourse, and the use of potentially productive instructional activities to support student learning. This was particularly important since PBL is not a typical learning environment to the students. Accordingly, determining learning process conjectures and ways to support student learning were the two main activities involved in the pre-implementation phase. The following section paragraph elaborates on these two activities.

Learning process conjectures

For the learning process conjectures, the researcher and the local PBL practitioner agreed that the procedures start with a short introduction of the PBL problems by the facilitators, followed by a presentation of PBL scenarios prior to group discussions. A group representative will then distribute the facilitator-prepared learning materials (the *PBL trigger* and the *PBL student task*) to the group members. The students then collaboratively work towards addressing the problems and issues. During the group discussion, the students would brainstorm the given scenarios, listing out critical information, their thoughts and opinions about it, and finally constructing inquiries in the form of learning issues. Being engaged in problem analysis will generate reasoning for the problems found in the PBL scenarios. From problem analysis, the students will identify what they know and they do not know of the issues in hand. Accordingly, they can determine what they want to learn more.

Students are encouraged to take on different roles during group discussions, such as being a team leader to steer the group's direction, scribe to compile and document important information, and group members to locate resources related to the problems under scrutiny. Throughout group discussions, the students would use the *PBL thinking tool* to help them manage information (see the next section for discussion on *PBL thinking tool*). Before ending the sessions, each group will be expected to divide the tasks to be accomplished during the individual learning period. The tasks for individual learning were divided from the learning issues generated by the groups. The task divisions will be highlighted since most of the students are part-timers, which means they are not staying near the university. Hence, they are more likely be able to meet with other group members only during class because meeting at other time might be impractical. Therefore, the facilitators should ensure each group divides the tasks properly and equitably among the group members.

During the individual learning, the students will mainly searched for the resources relevant to the tasks given and prepared drafts of the solutions for the next group tutorials. To maintain their collaboration during this individual study period, the students were encouraged to use emails and social media extensively to communicate with each other. In the next class meeting, each group member would report their individual learning to the group, verbally and in written drafts. At this stage, the students shared their individual learning outcome by drawing illustrations, clarifying uncertainties and drawing connections between their prior knowledge and the tasks under

discussion. To create a collaborative classroom culture, the inter-group discussion was conducted soon after the individual group discussion. The objectives of the inter-group discussion were to broaden their perspectives on the PBL scenario solutions by exposing them to a variety of approaches used by other groups; this was also to allow them to reflect on the group process (Ertmer and Simons, 2006).

During the inter-group discussions, all groups participated and each was encouraged to contribute their thoughts. Both facilitators moderated the inter-group discussion and added any major points that the students may have missed. An inter-group discussion involves groups taking turns to explain their learning issues; there will be several groups randomly picked by the facilitators to present their learning issues. Such measure was taken so that all group are attentive and ready to report. While a group presents their learning issues, other groups could participate by adding, arguing or proposing new points. Facilitators would note the students' details on the white boards, so that all groups are aware and clear about what is being discussed. Based on the collective efforts by each group member, the groups decided on a solution to the problem under scrutiny. Finally, the students reported on their findings in many forms according to the specific PBL problems. Depending on the complexity of the problem scenario, additional research may be required as the group narrows the problem solutions. Therefore, these PBL learning process conjectures could be elongated in a series of two or more tutorials. Figure 9 shows the learning process conjectures to illustrate how the PBL design implementation will carried out.

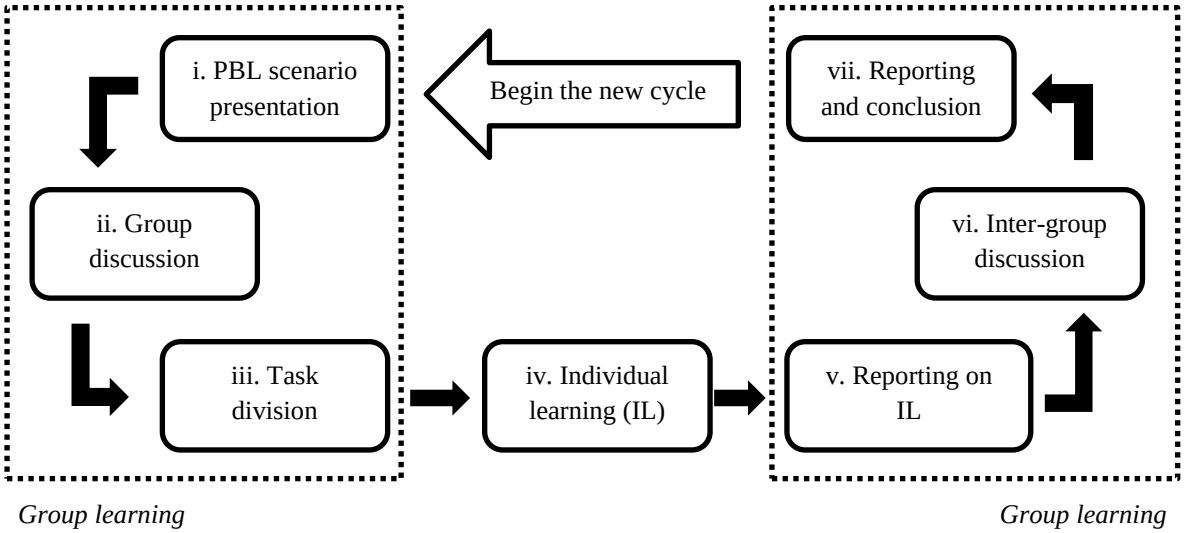

Figure 9: Learning process conjectures

Supporting student learning

As the students were novice and newly exposed to PBL, a plan to support student learning was majorly considered prior to implementation. PBL emphasises on efficient group discussion and facilitative roles of teachers to help student learn. Therefore, the *PBL thinking tool* will be used as an explicit tool to help students to articulate the information during PBL group discussion. Similarly, the facilitative role of teachers is clearly spelled out during this stage since both the researcher and the local PBL practitioner will be in the classroom to facilitate students' learning. The following sections details out the *PBL thinking tool* and the *role of facilitators* as means to support student learning.

PBL thinking tool

Consensus has been achieved with the local PBL practitioner during the design phase that the PBL thinking tool will be the tool for students to record their evolving ideas. During the group learning process, the group of students will be asked to use *PBL thinking tool*, a table with four different headings (*Facts, Ideas, Learning Issues* and *Action Plan*), as shown in Table 25:

Table 25: The PBL thinking tool

Facts	**Ideas**	**Learning Issues**	**Action plans**
What do we know?	**What do we think?**	**What do we need to know?**	**What should we do?**
• Information extracted from the problem scenarios • Identification of ambiguous notions	• Possible causes/effects/ideas/ solutions based on the facts identified • Consider to use own experience and previous knowledge	• Phrased as questions that lead to the problem solutions • 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 • Division of tasks

Source: adapted from Dean (2001), pg 11.

The aim of using the PBL thinking tool is to help students to explicitly articulate and expand information during group discussions. Each column requires students to devise different kind of

information with regards to the PBL problems under scrutiny. The *Facts* column includes information that the students can directly obtain from the PBL scenario. Students use *Ideas* column to link their prior knowledge and make reasoning to the information extracted in the *Facts* column. In the *Learning Issues* column, the students generate questions and hypothesize about the underlying causal mechanism that might help explain the information listed in the *Ideas* column. In the *Action Plan* column, students identify the concept they need to learn. Subsequently, the students divide the tasks among the group members based on the information generated in the *Learning Issues* column. By filling out the PBL thinking tool, the students are guided in determining the facts contained in the PBL scenario; they are also led to (1) develop feasible hypotheses underlying the problem, (2) identify learning issues to research, (3) externalize their thinking and (4) consider multiple aspects of their tasks.

Role of facilitators

During the online discourse with the local PBL practitioner, it was agreed that the researcher will present in the classroom while the local PBL practitioner will implement the PBL designs on her own. The role of the researcher was merely to observe the implementation process. However, after a series of meetings prior to implementing PBL at UPSI, the local PBL practitioner suggests that the researcher also involved himself in the implementation process rather than merely observing the implementation process. Hence, the researcher also took up the role of the local PBL practitioner during the PBL design implementation.

The researcher's multiple role as designer and practitioner at the same time have been discussed in various DBR literatures (for example see Barab and Squire, 2004; Joseph, 2004; Collins, 2012; and Hoadley, 2004). Barab and Squire (2004) suggested that a DBR researcher moves beyond observing, and involves systematically in engineering the context under study in order to improve learning. Hence, the researcher has intervened deliberately during the PBL design implementation. Throughout the course, the facilitators' role was to facilitate and guide the group learning process rather than provide information. In particular, the researchers' tasks were to consult with the groups, assist in clarifying the PBL scenarios, help in identifying various types of resources, ensure that the students are on the right track, suggest a better approach in group work and help them meet their deadlines.

In the early semester, the facilitator took a more dominant role in the tutorial activities to guide the students towards self-direction; he then gradually reduced the facilitation and scaffolding as the students became more familiar with the academic expectations posed on them (Ryan, 1993). This was in line with a recent study by Mohd-Yusof et al. (2011), who proposed that more motivation be given to Malaysian students who are new to the PBL approach. This could be done by providing more scaffolding and guidance in the preliminary PBL cycles, before gradually decreasing it as the semester proceeds. Unlike medical settings in which one tutor is allocated for each PBL group, this research adapted the floating facilitation style which had facilitators move around the groups during group work. The latter then, probed the students with questions that activated their prior knowledge and experiences. The students' responses to the open-ended questionnaires helped the facilitator to determine if further scaffolding is needed and the students' progresses are periodically monitored.

3.5.2 Implementation Phase

The implementation phase was carried out in two parts: *briefing the students* and *PBL design implementation*. The first four weeks of the implementation phase were devoted to preparing the students by eliciting their prior knowledge and introducing them to the PBL. Starting from week four until week 14, the PBL design was implemented, as shown in Table 26.

Table 26: Activities involved during the implementation phase of the PBL designs

Implementation Phase	**Week**	**Activity**
Briefing the students	1 (25th February 2012)	Interactive seminars on Constructivism and Conceptual Change theories
	2 (3rd March 2012)	
	3 (10th March 2012)	
	4 (17th March 2012)	Introduction to PBL
PBL Designs Implementation	4 (17th March 2012)	Introduction to PBL1
	5 (24th March 2012)	Follow up PBL1
	6 (31st March 2012)	Follow up PBL1
	7 (7th April 2012)	Presentation and submission of PBL1
	8 (14th April 2012)	Holiday (mid-term break)
	9 (21st April 2012)	Introduction to PBL2
	10 (28th April 2012)	Follow up to PBL2 (Reflection)

	11 (5th May 2012)	Holiday (Wesak Day) Submission of PBL2
	12 (12th May 2012)	Introduction to PBL3
	13 (19th May 2012)	Presentation and submission of PBL3
	14 (26th May 2012)	Open-ended questionnaire

The briefing sessions aimed to elicit the students´ understanding on *constructivism* and *conceptual change* theories. Both theories served as a foundation in the course, and they represented the current views of learning conception in sciences. The three weeks seminar were conducted interactively with the students, in which they were encouraged to participate in seminars by asking questions, share their thoughts and opinions. In a group, the students were also investigating science phenomena in relation to both theories. These briefing sessions were fully conducted by the local PBL practitioner. Generally, the students had fairly adequate understanding on *constructivism* and *conceptual change*.

In the fourth week, the students were introduced to PBL by the researcher. To explicitly introduce this new practice, each student was given the *Student Guide to PBL* booklet. According to the literature review, students should be made aware of new approach to teaching and learning, so that they could see the rationale of the implementation. The *Student Guide to PBL* contains introduction to PBL, characteristics of PBL, rationale for learning through PBL, depiction of PBL processes, proposed steps to approach the problems, roles responsibilities of the group members, expectations on the learning and a walk through a sample PBL scenario as an introduction to the PBL group learning process. This PBL scenario sample served as a warm up for them to get ideas on how the PBL will be conducted in the following weeks. Then, the students were asked to form their own group to exercise a sample of a PBL scenario. Through this way, the researcher could determine how to properly facilitate the students and what to expect during the implementation process.

To deal with the PBL scenario sample, the students were asked to use the *PBL thinking tool*. Examining the students' thinking tool helped the researcher to determine the former's cognitive pattern (e.g. the ways the students impose inquiries in their thinking tool). If all questions started with *What*, not *How* or *When*, then the students were considered less critical in articulating their cognitive ability. This collective information–obtained from the interactive seminars and PBL introduction session–gave better insights to both the researcher and the local PBL practitioner to

implement the PBL designs. Starting from Week 4, the PBL designs implementation was carried out with the aims to devise (to elaborate, to iterate) the PBL design from the learning process and means of supporting it. Table 27 shows different week's allocation to complete the specific PBL problems.

Table 27: Number of weeks required to complete the PBL problems

PBL Problem	Weeks to complete
PBL1: Constructivism	4 weeks
PBL2: Alternative Conception	3 weeks
PBL3: 21st Century Learning	2 weeks

As showed in Table 27, four weeks were devoted for students to complete their *PBL1: Constructivism*. This was reduced to three and two weeks for *PBL2: Alternative Conception* and *PBL3: 21st Century Learning* respectively. The pattern of week allocation for students to complete the tasks was descended following previous works' suggestion that students–being inexperienced in student-centred learning–may require more time to complete the first PBL cycles. As the semester proceeds and the students were getting familiar with PBL, the number of weeks allocated to complete the PBL topics were reduced. Also considered in deciding this pattern was the difficulty levels of the PBL topics.

The first PBL topics were more direct and less complex compared to the succeeding ones, in order to introduce the practice gradually to the inexperienced students. The implementation phase was also the data collection phase whereby the data on student learning and classroom practice were the primary data collected. Therefore, the PBL designs evolved as the implementation proceeds. To explain the actual events during the implementation stage, please refer to the field notes attached in *Appendix Q.* The field notes were devised from the researcher´s class observation and were written from what the researcher has carried out every week.

3.5.3 Reflection on the Implementation

This section represents my own reflection on the PBL design implementation in Malaysian teacher education context. This reflection is based on the weekly field-note observations. During the first week of the PBL design implementation, the course expectation and guidelines were discussed as a

large group. I have told the students that I expect them to work in teams and independently to solve the PBL problems. Clear expectation and mutual understanding between both parties (facilitators and students) should be laid out during the introductory sessions to avoid misunderstanding. In addition, students also were made aware of change of role that they should take up in the PBL learning environment**.** In the same manner, roles of the facilitators that are very different from the role of lecturer were also made clear to them to avoid any misinterpretations.

At the beginning week of the implementation (Week 4 and Week 5), the students' experiences were chaotic, with feelings of uncertainty as they identified their learning needs and set their own research objectives. These students told me that they would like to have more direction to begin researching the issues (e.g. in narrowing the scope of their investigations, direct instruction on what they should do next). I was uncertain whether to give them much freedom or help them move forward–an action that would potentially violate the PBL principles. PBL is devoted for students' self-directed learning whereby they could take their own initiative on their learning and decide their own learning goals. Therefore, findings the right balance between these two ends was important especially for students who are not familiar with PBL.

In the first week of the PBL designs implementations (Week 4), I did not really emphasize on task division among the group members before the class dismissed. In the second week (Week 5), students told me that meeting with their group members beyond the class time was difficult since they live far from each other. They had to meet beyond the class time since they were unclear on what task they should do during individual learning. Therefore, I decided to emphasize on task division among the group members just before the class ends in this week. I asked them to write a note on how they would divide the tasks among the group members. In my opinion, they should leave the class with clear expectation of which tasks they should deal with during the individual learning. I told them that the tasks were expected to be completed individually and independently. Hence, there was no expectation that the groups had to meet sometime after class. To make myself available during the individual learning period, I encouraged them to ask me questions via emails, via social media like *Skype* or *Facebook*, during office hours, or before or after the class. They could also possibly set up a group meeting with me through appointment. I normally received their questions via e-mail. In my opinion, this was a feasible way to manage issues that concerned students who live afar from the university.

In Week 5, there was a misunderstanding among the students on the tasks they should deal with. By evaluating the *PBL thinking tools* filled by the students, it was concluded that most of the groups would like to evaluate the personality of the teacher in the video, not the constructivism principles behind her lessons. I expected them to present the problem solution in today´s classrooms. However, this is not possible since students misinterpret the tasks given to them. They could finish the problem solutions, but the quality of their work was questionable. Therefore, I changed my plan. Instead of asking them to present their problem solution, I presented them again with the *PBL trigger* of a video showing a teacher who teaches her pupils on *Body Parts* topic. After two weeks (Week 4 and Week 5) working on PBL1, there were six learning issues that the groups had to resolve in Week 6. However, only one group (Izzat Group) had answered all six learning issues; the remaining six groups only completed the evaluation tools (either rubric or checklist) and suggestions to improve the teaching and learning sessions to align with the constructivism principles. At this particular point, I realized that students were misinterpreted the tasks, and unable to produce their own learning issues. Students were still struggling to cope with PBL.

After a brief discussion with the fellow facilitator cum local PBL practitioner, we promptly decided that we wanted to give a mini lecture to students for them to get a clearer picture on what the tasks were all about. Although we did not plan to conduct any formal lectures, we were still prepared in case they are needed. Hence, I concluded that in the preliminary weeks of the PBL design implementation, the students required a higher level of guidance and facilitations in more concrete manners. Later on, as they gained more confidence after having gone through several PBL cycles, the facilitators could take on different roles as they stepped back and supported the students' independency.

I always bear in my mind that it is important for me to continually assess the teaching and learning process. While students worked on their PBL problems, I observed and listened to them and asked them to reflect on their learning experience. The students' views and concerns were the important sources to improve the PBL designs. For example, I was planning to have a group presentation for each PBL task. However, the students' informal verbal feedback after completing PBL1 (in Week 7) revealed that too many presentations were boring (since they had to do several group presentations during PBL1). Therefore, I substituted group presentation with *group written reflection.* In PBL2 which started from Week 9, there is no group or individual presentations.

In Week 9, during the group discussion on PBL2, I allocated 5-7minutes to monitor the students' thinking; I probed questions, and provided some guidance. Some groups were eagerly waiting for me to come to their groups, while some were merely asking me some additional questions to verify their current progress before proceeding to the next steps. This showed unequal progressions among the PBL groups. In this class, the students came from two main different academic backgrounds; in-service teachers (with at least 5 years of teaching experiences in schools) and prospective teachers (new graduates from of Bachelor of Education (B.Ed) degree). The in-service teachers groups and mixed teachers groups (group consist of both pre-service and in-service teachers) seemed more adaptable to the PBL approach compared to the pre-service teachers groups. In the first week of PBL design implementation, I give the freedom for students to choose their own group members. Perhaps, I should consider this background when the students formed their PBL groups during the early semester. A group consist of both pre-service and in-service teachers might be the most desirable to create a dynamic PBL group.

Problems or difficulties should be expected since the students were new to PBL. As I facilitated, some groups faced more prolonged difficulties with their PBL problem than other groups. All PBL problems were multi-faceted and with such complexity, the groups have spent more time and energy to define the problems, explore the issues, discuss points, and reach consensus. In week 10, while students were working on PBL2, they informed me that they would like to have more directions–in terms of narrowing the scope–as they researched the issues. I´m fully aware of their frustrations within the limited time. On the other hand, I wanted to give them as much freedom to search, think and analyse for themselves. So I continued to work with the students and find the right balance of facilitating and allowing them to decide on their own. PBL2 is relatively short time for students to deal with since I allocate them for only 3 weeks to complete the tasks compared to 4 weeks in PBL1. In addition, none of them have the experience in writing the academic journal before as demanded in PBL2. However, I do believe that they can do it and this is just a beginning for them to get acquainted with the academic writings.

Reflecting on my role as a PBL facilitator, my tasks was to make sure that the students have defined the problem thoroughly; I also had to refocus them on the goal or on the problems' elements that they might have overlooked. To some extend, I also suggested resources. As the students began to exercise on solving the problem, I asked them to justify their ideas with concept or knowledge from

their research, prior knowledge or reading. If the students were stuck, I would ask them leading questions to guide them with essential piece of information before asking them to apply the information to the problem. I also encouraged them to ask questions like “what is wrong here?”, “what are the factors involved?”, “what kind of problem is this?”, “what do I know about this problem?”, “what do I need to know?” and “where can I find it more?” As the students began to work on the PBL problem and consider solutions, I asked them to justify their ideas with concepts or knowledge from their research or readings. As far as I concerned, this is the way how I deal with the interplay between issues of giving sufficient facilitation at one hand, and upholding the PBL principles at another.

In week 13, I bring back the group presentation whereby group of students are required to present their 21 century school science laboratory layout. A group told me that they spent more time out of class then they did in the class. They also mentioned about burden from other course as well. Nevertheless, given the limited amount of time (which is only two weeks for the PBL3) available, every group was ready for their oral presentation, and each group did a commendable job on completing the PBL problem. In addition, a group presents their layout in different ways in which they made the layout plan more interactive. During the whole class discussion, I added any major concept and points that they have missed. In conclusion, it is apparent that the PBL design is not followed exactly how it is being designed. As the implementation proceeded, the PBL design was adjusted and iterated. Based on the formal feedback such as reflection, observations and informal sources such as dialogues with students and emails, , I revisited and revised the delivery, the timing, and the assessment methods.

3.6 Conclusions

The first design phase activity involves compiling the initial findings were derived from three elements; theory, practice and context. The focus of the initial findings on student learning, constraints and possibilities have given a holistic view to the PBL design development. As far as the researcher could determine, the initial findings would serve as a foundation for PBL designs development in the second design phase. There were three elements involved in developing the PBL designs in the second design phase; the compilation of the initial findings, the PBL curriculum elements and the analysis of the course. The preliminary steps in designing the course into the PBL designs involved rearranging the course outline into three PBL problems (PBL1, PBL2 and PBL3),

and matching the learning outcome to specific PBL topics. Once these were determined, the PBL toolkit was developed. The PBL toolkit was developed for both the facilitators and the students; it consisted of lesson plan, problem scenario, written reflection and assessment. To fulfil the need of preparing the students before embarking in the PBL learning environment, the *Students Guide to PBL* was developed to help the students to get preliminary insights on the new practice in terms of its rationale, its learning process, roles, and a sample PBL scenario. The intact PBL designs from the second design phase were brought into practice in the third design phase.

The third design phase is further divided into three sub-phases; pre-implementation, implementation, and reflection on the implementation. In the pre-implementation phase, the learning process conjectures was determined so that the researcher and the local PBL practitioner were clear on the sequences and events during the PBL designs implementations. Succinctly, a cycle of learning process conjectures consist of two group learning cycles and an individual learning. Depending on the complexity of the PBL problems, various numbers of learning cycles were needed to complete the PBL problems. To support student learning in PBL, the *PBL thinking tool* table was used as a tool to help groups manage their discussions by considering various information and reasoning as demanded in the table. The role of facilitators was also determined beforehand in which both the researcher and the local PBL practitioner would assume that role. Generally, a more structured facilitation style will be adapted during the preliminary weeks of implementation. Later on, as the students get used to PBL learning, the facilitations were reduced to give more ownerships of learning to the students, particularly by letting them decide on their own learning.

The implementation phase was divided into two main activities: *briefing the students* and *PBL designs implementation*. In *briefing the students*, the class was carried out in interactive seminar that focused on two main theories in science learning; constructivism and conceptual change. After that, the students were introduced to PBL by exposing them to a sample scenario for them to work in groups. The *PBL designs implementation* started at the fourth week and each PBL problem (PBL1, PBL2 and PBL3) required various number of weeks and learning cycles according to the learning outcome and the students' need. This was to demonstrate that the PBL designs have not followed slavishly if accumulated evidence and circumstances led the researcher to believe they don't apply. Therefore, in each PBL cycle, the implementation was used as an opportunity to collect data in

order to inform the subsequent cycle of PBL. Finally, the researcher's reflection provides the perspectives on the PBL designs implementation. Problems and challenges at various levels were attended in various ways along the implementation process.

CHAPTER 4

EMPIRICAL RESEARCH FINDINGS

4.1 Introduction

This chapter specifically presents the empirical research findings during the PBL design implementation in Universiti Pendidikan Sultan Idris (UPSI). As stated in the previous chapter, this implementation phase was also the data collection and analysis phase. For the data collection, both qualitative and quantitative approaches were employed to gain insights on the impact of PBL design implementation on students' learning and students' learning environment. Accordingly, this chapter is divided into two sections: qualitative findings and quantitative findings. The qualitative findings are presented in the form of journal articles while the quantitative findings were derived from a questionnaire that aimed to elicit the students´ perceptions on the PBL learning environment.

4.2 Empirical Research Findings

4.2.1 Qualitative Findings

The qualitative findings produced were rich descriptions from which greater insight was gained on the impact of the PBL design implementation on the students' learning, and their learning environment. Observation, students´ individual and group written reflections, and interviews were the data collection techniques used to fulfill the purpose. As for the data analysis, the research has adopted an inductive analytical approach where themes from the qualitative-oriented data (observation, student written reflection and interview) were compared and contrasted. The qualitative findings were reported in the form of journal articles. Table 28 summarises the findings from the fifth article (see *Appendix R* for full article):

Table 28: Empirical research findings on the impact of the PBL design implementation on students' learning and students' learning environment

Article 5	
Title	**Impact of Problem Based Learning (PBL) Implementation on Student Learning.**
Research findings	**i. Impact of PBL on student learning:** *a. Impact of PBL on knowledge and skills* PBL has long been claimed for its ability to enhance the acquisition, development and improvement of students' knowledge and skills. The findings of this study indicated that the students were aware of the knowledge and the variety of skills they acquired, developed and improved throughout the course *b. Impact of PBL on group processing* Sufficient evidence were found on how the students perceived the benefits of PBL from the group processing's point of view. The group processing activities including brainstorming, discussions and resource locating have served as opportunities for them to validate arguments, exchange and expand ideas, which could result in better resolutions of the tasks **ii. Students´ reflection on learning in PBL:** *a. Reflection on PBL group process* The students remarked the importance of having roles among group members, and for the latter to carry out their roles responsibly. Effective leaderships in group is the key to a fruitful group discussions. The students also reflected that their group should have a better planning on the group timetable whereby proper timeline on group schedule should be explicit and made known to each of the group members. *b. Reflection on PBL content and delivery* On PBL problems and assessment, the students reflected that it should be more directive, clearer, considerate of their prior knowledge and inclusive of the current issues in science education. On facilitation and instruction, the students' reflection generally called for more facilitations from the facilitators which including suggesting resources, clearer instruction and detail introduction of PBL concepts. **iii. Challenges in PBL learning** *a. Initial anxiety and gradual reconciliation* Anxiety and struggle experienced by the students specifically during the initial stage was evidently expressed by most of them. However, the student also remarked that as they got acquainted with the PBL approach, they became more

confident and skillful in dealing with the PBL problem scenarios.

b. Insufficient time

Time constraint was among the most prevalent issue raised by the students. Comments such as *´insufficient time´* and *´time is not enough´* were typically found in the students´ individual reflections when asked about the challenges they faced in learning through PBL. Insufficient time was experienced at different stage of the PBL learning process but most students did not have sufficient time during the discussions.

c. Group issues

There was a lack of cooperation among some of the group members, who took advantage of others group members ability, and the difficulty to meet with group members beyond class time.

This article reports on the impact of PBL on students' learning, their reflections on learning, and the challenges of learning in a PBL environment. As shown in Table 28, PBL has impacted the students' learning in terms of their knowledge, skills and group processing. The students were able to identify the attainment of skills and values during the group learning process, during which they were involved in the reasoning and development of thoughts and ideas. The students also indicated that the PBL has helped them to develop advanced cognitive abilities such as communication, problem solving, self-directed learning, and critical and creative thinking. In fact, the group learning process has also enhanced their leadership, ability to cooperate, and information management skills. The students also found that the knowledge and skills they acquired were applicable in classroom and daily life. Such capabilities are important for school teachers in dealing with the complexity of today´s classrooms for school teachers.

To create awareness of their own learning, students in a PBL learning environment are continuously encouraged to reflect on their learning process. Opportunities for reflection make students realize how to improve their learning experience. Based on the analysis, the students' reflection could be divided into two themes: reflection on PBL group process and reflection on PBL content and delivery. Students reflect that it is not only important to assign specific roles to group members, but it is equally important to effectively take up their roles by active participations in the group discussions. In addition, the different roles of group members should be rotated to ensure that each member get to experience different roles, and can contribute from different perspectives during the group learning process. Reflecting on the efficiency of group learning

practices, the students called for a better planning on group timetable. This included an explicit timetable on the deadlines of group work submission, the time to discuss beyond class time and the time to compile the data.

As the students in this research were mostly new to student-centered learning, learning in PBL might impose some challenges, as the students tried to cope with the new learning environment. They had to become more independent in their learning, and they had to rely on group members and confront the challenges of group works while learning in the new environment. Apparently, learning in PBL was very different from the one they were acquainted to. From the student's perspective, initial anxiety, insufficient time and group issues were the three main challenges. Uncertainties and difficulties in dealing with the tasks were the most prevalent comments received during the initial period of the semester. This initial anxiety can be explained by looking at the students' background: they used to learn in a conventional way, in which they were the passive receiver of knowledge. In contrast, the PBL learning environment required them to actively participate in group discussions and decide their own learning goals.

Time insufficiency was also a major constraint to the students. From the interview excerpts, it was gathered that the students required more time to familiarize themselves with the PBL environment. Particularly in Malaysia, it was expected that the students may need more time to get comfortable with the nature of learning through PBL, since their previous learning experiences were dominated by teacher-centred and rote learning approaches, which contradicted the PBL learning environment. The students were reported to perceive PBL as being too time-consuming, although they enjoyed working in groups. Insufficient time had been the recurring issue among the students during the different stages of the PBL learning process. In a group, the students unanimously agreed that they required more time to deal with the tasks. Several issues were reported by the students: having few members taking advantage of another, and difficulty in meeting with group members beyond class time. Engaging in a PBL approach meant that the students were challenged and had to confront learning in a mode different from the one they were used to.

4.2.2 Quantitative Findings

The quantitative findings were derived from a questionnaire that elicited the students' perceptions on the PBL learning environment. Thirty respondents answered the questionnaire, with a response rate of 94 percent. The questionnaire consisted of five dimensions*: general impression, group learning process, the PBL task, the facilitator and PBL benefits and perspectives*, (see *Appendix H* for the questionnaire on PBL learning environment). Each dimension consisted of various number of items. SPSS Version 17 was used to analyze the data in order to obtain descriptive-oriented data such as means and standard deviations (SD). Each item that received a mean of 2.50 represented the equilibrium point. Each item was accompanied by a 4-point Likert scale, with 1 denoting the most disagreeable item and 4 denoting the most agreeable item. Therefore, items with a mean value greater than 2.50 (>2.50) reflected the degree of the students´ agreements with the statement, while items with a mean value less than 2.50 (<2.50) reflected the degree of the students´ disagreements with the statements put forward to them. The findings are presented according to the five dimensions of the questionnaire. Table 29 reports the mean and SD for each item in the *general impression* dimension:

Table 29: Mean and SD for items in *general impression*

1. General impression		**N**	**Mean**	**SD**
a.	In general, I´ve worked enthusiastically during this course	30	3.53	.571
b.	I spent a lot of time studying for this course	30	3.43	.568
c.	The subject matter in this course was valuable for my study	30	3.70	.466
d.	The subject matter for this course was difficult to understand	30	1.70	.837
e.	I have learned a lot during this course	30	3.70	.466
f.	I found the subject matter in this course interesting	30	3.63	.556

The *general impression* dimension invited the students to response with a variety of perspectives, particularly on their experience in learning in the PBL learning environment. Among the perspectives drawn included the time they spent, the subject matters and the learning impact. It was evident that the students were enthusiastic ($\bar{x}$=3.53) to work/learn in a PBL learning environment since they found that the subject

matter was interesting ($\bar{x}$=3.63) and valuable ($\bar{x}$=3.70). To a high degree of agreement, the students remarked that they had learned a lot during the course ($\bar{x}$=3.70). Though the subject matter was not difficult ($\bar{x}$=1.70), the students agreed that they had spent a lot of time ($\bar{x}$=3.43) in dealing with the PBL. These findings indicated that students were adaptable to the PBL learning environment despite they are not familiar with the approach before. Time allocation should be among the main consideration a university teacher should be aware of, since new students to PBL need relatively more time to deal with the PBL tasks.

The group learning process in the PBL was unique in a way that it allowed negotiations among group members and management of information. The students´ responses on the dimension *learning process in group* is presented in Table 30. As PBL emphasises on group learning process, this dimension sought the students' feelings about working in a group.

Table 30: Mean and SD for items in *group learning process*

2. Learning process in group		**N**	**Mean**	**SD**
a.	I found it is a pleasure to work in my current group	30	3.40	.855
b.	I feel comfortable asking for help from others in my group	30	3.63	.556
c.	I feel that my group members listen to me when I present information.	30	3.67	.479
d.	I feel that my group members show respect for me and my learning style.	30	3.67	.479
e.	I feel comfortable sharing information with others.	30	3.83	.379
f.	Evaluating the individual efforts of me and my group members helped our group function well.	30	3.67	.479
g.	As a result of this learning process, my ability to find, read and analyze information has improved.	30	3.70	.466

For this dimension, the students have indicated a higher degree of agreement for all the items since the mean value for each item was 3.40 and above. In particular, they felt comfortable in sharing information ($\bar{x}$=3.83) and asking for help ($\bar{x}$=3.63). When asked about their perceptions on their group members, the students found that it was a pleasure

to work within their current group ($\bar{x}$=3.40), since the group members listened to them while they presented information ($\bar{x}$=3.67), and showed respect for their learning styles ($\bar{x}$=3.67). This finding indicated that the students were committed to work in their current group since they felt comfortable, and their group members could accept the different approach of learning.

Mutual respect among the group members was actually the key ingredient to achieve an effective group collaboration in a PBL learning environment. Furthermore, the students also agreed that the evaluation and appreciation of their efforts and contributions in their group learning ($\bar{x}$=3.67) have enhanced their group function. In particular, the students agreed that their ability to find, reach and analyse information has improved ($\bar{x}$=3.70). To deal with the problems, the students had to deal with vast information and sources, hence, garnering them the ability that is always desirable.

The third dimension of the questionnaire, *the PBL task* has specifically sought the students' perceptions on the clarity and quality of the PBL problems presented to them. Table 31 shows the five items of this dimension along with their respective means and SD values.

Table 31: Mean and SD for items in *the PBL task*

3. The PBL Task		**N**	**Mean**	**SD**
a.	The tasks were clearly stated	30	3.43	.626
b.	The tasks prescribe too much of what ones was expected to do	30	2.93	.828
c.	The tasks provide sufficient stimulus to group discussion	30	3.37	.615
d.	The tasks provide sufficient cues to formulate learning issues	30	3.27	.583
e.	The tasks stimulate self-study sufficiently	30	3.40	.675

In this research, the PBL tasks were presented in the form of three PBL problems (PBL1: *Constructivism*, PBL2: *Alternative Conception* and PBL3: *21st Century Learning*). The PBL problems were designed based on many considerations such as their ability to stimulate learning, provide considerable amount of hints and promote self-directed

learning. A good PBL problem should be able to foster flexible thinking; it must be ill-structured, open-ended, realistic and resonant of the students' background. With regards to the students' backgrounds, three PBL problems that revolved around school issues, learning in science and science education were designed. These issues appeared to resonate with the science teachers in this research.

The PBL tasks dimension invited the students to response on the characteristics of the three PBL tasks presented to them. It was prevalent that the PBL tasks were clear to them ($\bar{x}$=3.43) since it provided sufficient stimulus ($\bar{x}$=3.37) for the groups to go forward with the group discussion and hence, formulate the learning issues. However, when the students were asked whether the PBL tasks have prescribed too much of what they expected, the students' responses were relatively low ($\bar{x}$=2.93) compared to their responses on other items in this dimension. The response pattern for *the PBL tasks* has indicated that the PBL tasks were appropriate to the students since it provided sufficient cues and stimulus ($\bar{x}$=3.27); at the same time, it did not reveal too much information that might ruin the PBL principles that devote on self-directed learning. In addition, the students agreed ($\bar{x}$=3.40) that the PBL tasks have stimulated self-study sufficiently during the learning process (self-study is students´ ability to formulate their own learning goals, search for relevance sources, argue with group members, and decide the best approach to deal with problems).

The fourth dimension, *the facilitator*, has sought the students to response on the facilitations given during the PBL design implementation. The students' responses on *the facilitator* items, which were based on means and SD, are presented in the following table:

Table 32: Mean and SD for items in *the facilitator*

4. The Facilitator	**N**	**Mean**	**SD**
a. The facilitators appeared to be aware of the principles of problem based learning (PBL)	30	3.77	.430
b. The facilitators encouraged all students to participate in group discussions	30	3.77	.504
c. The facilitators help me develop my reasoning process by	30	3.77	.430

	posing questions, and challenging and critiquing information presented.			
d.	The facilitators guide and intervene when necessary to keep group on track.	30	3.80	.407
e.	The facilitators encouraged the use of a variety of resources.	30	3.77	.504
f.	The facilitators listen and respond well to student concerns and problems.	30	3.93	.254
g.	The facilitators appeared to be enthusiastic about guiding my group.	30	3.87	.346

In a PBL learning environment, a teacher facilitates the learning process rather than provides knowledge. Therefore, the teacher of PBL is often called "facilitator". As a facilitator, the teacher's responsibility is to monitor group learning process. This includes scaffolding students' learning through questioning strategies, encouraging students to externalize their thinking, guiding the development of higher order thinking skills and developing awareness of learning progressions. In this research, both the researcher and the local PBL practitioner have acted as the facilitators to the group of students during the PBL design implementation phase. Generally, a more structured and directive facilitation style was adopted during the early semester, which faded as the students became more experience and acquainted with PBL.

Based on the students response, most of them strongly agreed with the facilitations provided to them since they perceived the facilitators as being aware of the PBL principles ($\bar{x}$=3.77). They also strongly agreed that the facilitators were enthusiastic in guiding the group ($\bar{x}$=3.87), particularly by listening and responding well to the former's concerns and problems ($\bar{x}$=3.93). During the group discussions, the students verified that the facilitators had only intervened when necessary ($\bar{x}$=3.80), and had assisted them in developing necessary skills ($\bar{x}$=3.77). As a PBL facilitator, it is important to be aware of "how" and "when" to intervene a group of students. Students should be given the opportunity to learn on their own. At the same time, facilitators should ensure that students do not derail from the learning outcomes. Finding the right balance between facilitating and granting students' freedom is also crucial in achieving appropriate facilitations. In particular, the students also confirmed that the facilitators had encouraged

all group members' participations ($\bar{x}$=3.77) and made the latter approach a variety of sources ($\bar{x}$=3.77).

The last dimension of the questionnaire, *PBL benefits and perspectives*, has required the students to rate their agreements on the benefits of the PBL learning environment and their commitments to sign up for another PBL class in the next semester.

Table 33: Mean and SD for items in *PBL benefits and perspectives*

5.	**PBL Benefits and Perspectives**	**N**	**Mean**	**SD**
a.	Process of solving a problem is more beneficial than finding a solution	30	3.63	.490
b.	PBL learning environment promotes open discussions	30	3.70	.466
c.	PBL learning environment promotes team work	30	3.83	.379
d.	I´m interested in taking another PBL class in the next semester	30	3.40	.675

For the first three items in this dimension, the students clearly appreciated the PBL learning process ($\bar{x}$=3.63) since it has encouraged them to learn in a group ($\bar{x}$=3.83), and has inculcated open discussion among them ($\bar{x}$=3.70). During the PBL design implementation, the students did not only discuss within their group, but also with other groups (inter-group discussion). The aim of the inter-group discussion was to expose the students to other groups' approaches in dealing with the PBL problems. The groups were randomly chosen by the facilitators to present to the rest of the groups, particularly on their approach to the PBL problems. This creates a mutual learning environment in which students not only learn from their group members, but also from other groups.

4.3 Conclusions

As a teaching and learning approach that emphasises on both the acquisition of knowledge, competencies and skills among learners, PBL has gained significance attention among educational researchers who enquired its impact on students' learning.

With no exception, the findings of this study have indicated that the students were aware of the knowledge and the variety of skills they acquired, developed and improved throughout the course. The PBL activities that required the students to be actively involved in the learning process were linked to the knowledge and skills they acquired. The group learning activities–which included brainstorming, discussing, arguing, presenting and locating resources–have served as an opportunity for them to validate arguments, and exchange and expand ideas, resulting in better resolutions of the tasks. The students also remarked their favour towards PBL: they felt comfortable sharing information and asking for help from the other group members. In managing the information, the students pointed out that their ability to find, reach and analyse information has improved, making them learn a lot during the activities.

Despite various measures considered in developing the PBL designs, the students still faced challenges and difficulties during their learning. Time constraint was among the major issues raised by the students. The students indicated that they needed more time during the discussion, specifically for completing the tasks, and meeting with their group members, and even for understanding the PBL tasks itself. In general, they also needed time to familiarize with the PBL approach, especially when they were the novices in an active learning environment, left alone the PBL approach. The findings also indicated that facilitators play a significant role in guiding and coaching, in order to ease the anxiety and struggles faced by students during early PBL tasks. These challenges so far, were elicited from the students during their participation in PBL; such a discovery provided important insights from PBL delivery perspectives.

Though the students were struggling to cope with the PBL during the early semesters, they were generally optimist with the new approach at the conclusions of the semester. This was evident from their questionnaire responses on the final week of the semester: for most of the items in the questionnaire, the students have rated their higher agreement on the various aspects of the PBL learning environment. The students found that the learning process in a group was enjoyable and comfortable. In the same magnitude, they agreed that the PBL tasks presented to them were clear, and were provided with sufficient cues. At the same time, the PBL tasks were not prescribed with too much expectations that might violate the PBL learning principles. Having a good PBL problem is necessary, but not sufficient for an effective PBL learning environment. From facilitation perspectives,

the students have rated their high agreement on the awareness, encouragement, attentiveness and enthusiasm of the facilitators in facilitating their groups. Hence, the role of facilitators is critical in making PBL function well. A PBL facilitator should find the right balance between facilitating and letting the students learn on their own.

However, the students have rated their disagreements on an item, which sought them to indicate the difficulty of the course content. The students disagreed that this course was difficult, but at the same time, they agreed that they needed more time to deal with the tasks. Hence, it could be concluded that students' optimism towards PBL should be accompanied by good PBL problems, sufficient time allocation, proper facilitation and a deliberate plan of the learning conjectures. As student centred learning becoming more common in higher education, students becoming more optimist and challenge them selves to embark and experience innovative learning environment.

CHAPTER 5

REVISITING RESEARCH QUESTIONS AND PERSPECTIVES

5.1 Introduction

As stated in the first chapter, the main research question is: *What are the impact, potential and constraints of PBL implementation in Malaysia and in teacher education?* Entailing this main research question, the research is specifies into four research questions as follows:

v. *What is the present knowledge of the impact, potentials and constraints of implementing PBL in Malaysia and in teacher education?*

vi. *In what ways can PBL design be suited to the Malaysian teacher education?*

vii. *What are the potentials and constraints for the implementation process of the PBL design?*

viii. *How do the PBL design implementations impact the students´ learning and their learning environment?*

This chapter addresses each of these research questions in a more specific manner than the previous chapter. The chapter consists of four main sections, with each being devoted to revisiting each specific question:

i. The first section deals with the first research question which enquires on the present impact, potentials and constraints of the PBL implementation in two areas: Malaysian higher education and teacher education. This research question was answered in the first design phase.

ii. The second section discusses the second research question–a design-oriented question–which queries on how the PBL design can be suited to the Malaysian teacher education. This research question was answered through the use of DBR as the research methodology.

iii. The third section presents the third research question which enquires on the potential and constraints of the PBL design during implementation in the Malaysian teacher education context. This research question was answered in the third design phase.

iv. The fourth section focuses on the fourth research question which enquires the impact of the PBL design implementation on the students' learning and students´ learning environment. This particular question was answered from the empirical research findings gathered during the PBL design implementation phase. The last section of this chapter concludes the study by synthesizing all the research questions and highlighting the research contributions.

5.2 Revisiting Research Question 1 (RQ1)

What is the present knowledge on impact, potentials and constraints of implementing PBL in Malaysia and in teacher education?

Accumulating the information from the literature review, partnerships with a local PBL practitioner and collaborating with colleagues, the impact, potentials and constraints of PBL implementation in Malaysia and in teacher education are are articulated as follows.

The impact of PBL on student learning was determined in the form of literature review focusing on (1) PBL implementation in Malaysian higher education and (2) PBL implementation in teacher education. The former concerns how PBL has impacted the Malaysian higher education students regardless of the field of implementation while the latter concerned how PBL has impacted the students in teacher education regardless of geographical boundaries. Having scrutinized both works, it was concluded that the PBL has been a successful approach in both Malaysian higher education context and in teacher education due to the favourable impact on student learning. Despite the students' familiarity with the conventional ways of teaching and learning approach, they were relatively adaptable to the PBL approach and they were aware of the skills and competencies they possessed after participating in the new learning environment. In teacher education, the research findings showed acquisition of pedagogical skills among

pre-service teachers, which proves that PBL is suitable for teacher education. The PBL design should be developed with the aims of addressing Malaysian higher education students´ background that are barely exposed to student-centred learning. Structured scaffolding, facilitation, guide and support should be of prime concerns for the Malaysian university teachers if they are intended to implement PBL in their courses.

The classroom facilities in Malaysian higher education is favourable for PBL in the sense that they can be manipulated. Despite the lack of tutorial rooms, movable chairs with attached small desk will make it easy for the students to form their own group and create their own learning space. Good internet connection within the classroom is a good opportunity that should not be neglected. During the PBL learning process, the use of internet to search for sources should be explicitly laid out.

Supporting students' learning in PBL can be gauged from different perspectives. Different ´amount´ of facilitation or too much instruction given to students will violate the PBL principles that demand student be self-directed in their learning. On the other hand, lack of facilitations might impose tensions on the students since they are not familiar with the new learning approach. Hence, explicit learning tool and learning process conjectures should also be considered to support the students' group learning.

As the Malaysian higher education is highly centralized, support from university administrations is important for any change in classroom practice. The Malaysian higher education is generally very supportive of the implementation of the student-centered approach, including the PBL. This is evident from the Malaysian higher education's report (see National Higher Education Action Plan Phase 2: 2011-2015) that encourages the implementation of student-centered learning in higher education. In UPSI, the establishment of the community of practices that identified themselves as *i-PBL team* and the ongoing efforts to develop UPSI´s own PBL model provides additional supports for the researcher. However, PBL implementation shouldn´t be in a standstill in classrooms or in teacher education institutions. Opportunity should be taken to disseminate PBL in programs at university-wide level.

5.3 Revisiting Research Question 2 (RQ2)

In what ways the PBL design can be suited to the Malaysian teacher education?

This research concerns the development, implementation and evaluation of the PBL design for Malaysia teacher education. To guide this research inquiry, Design Based Research (DBR) was used as the methodology. The primary aim of this methodology was to merge research and practice by addressing both theory and practice. The emphasis on theory has reflected the aims of generative, sustained and long term effect of educational improvement, while the emphasis on the practice elements have reflected the aims of developing locally usable knowledge. As a methodology, DBR pursues the goals of developing an effective learning environment that is practical and scientifically trustworthy. This method has allowed the researcher to intervene deliberately in the study, which made it possible for the PBL design to undergo iteration during the implementation phase. This iteration has led to the "contextualization" of the PBL design according to the students' need and available facilities.

Through the DBR methodology, the development and implementation of the PBL design could better suited to the local setting i.e. Malaysian teacher education. Since the beginning of the design phase, this research has emphasised on the interplay between theory, practice and context. Partnerships were established with a local PBL practitioner at the preliminary design phase to determine the contextual potential and constraints. In this research, the local PBL practitioner was a professor at Universiti Pendidikan Sultan Idris (UPSI) who was enthusiastic about PBL and actively implementing the method in her classes. This partnership contribute largely to achieve the PBL designs that are correspond to the Malaysian teacher education context since the local practitioner knows more about the complexity of the culture, values objectives, amis and operating educational practices. A researcher/designer on the other hand is often well-trained to conduct rigorous educational research. The information on contextual potential and constraints such as facilities, local ethos, management support, current students´ cognitive level and university´s missions and aims were used to develop the PBL designs in hope that the resultant PBL design is sensitive to local conditions. During the implementation phase, the PBL design may not being executed as planned since the DBR researcher had

always allowed room for improvements, pragmatic and iterative on what would work as the implementation unfolded. The result was the PBL designs that suited the Malaysian teacher education context, and this achievement was made possible through the use of DBR as the research methodology.

5.4 Revisiting Research Question 3 (RQ3)

What are the potentials and constraints for the implementation process of the PBL design?

The potential for PBL design implementation in Malaysian higher education are evident from the higher education policy that favours student-centred learning in higher education, support from top university management and community of practices, and flexibility of curriculum and course structure that allow university teachers to change their pedagogical approaches. There were also several constraints observed during the PBL design implementation, such as the students´ background (passive participation in group learning, lack of motivation, and part-timers), lack of facilities for student-centred learning, and the need to prepare the students and academic staff before embarking on this new approach. Some of these constraints were highlighted further in this section to demonstrate how they could be readdressed as potentials during the PBL design implementation.

Facilities can be one of the main constraints in implementing PBL especially in Malaysian higher education since it emphasizes on teacher centred learning. In one of the best PBL practice such as in AAU, the students are allocated a group room where the group learning process takes place. In UPSI, however, there are no such facilities. Most of the learning spaces in UPSI were built for mass lecture, such as the lecture halls that have fixed setting of table and chairs. These kinds of facilities are not favourable for PBL since it requires students to learn in a group. Yet, there is a potential for implementing this new approach in UPSI because the university has many big tutorial rooms that are equipped with movable chairs with attached small desk. These tutorial rooms are also fully equipped with LCD projectors and whiteboards. Additionally, the space in these rooms can be manipulated by moving those chairs and arranging them in circles, so that the

students can form their own group. By manipulating this space, group spaces can still be made available for group discussions. In the study, since all the groups were in the same space (in a big tutorial room), inter-group discussions were also conducted. This inter-group discussions were part of the PBL learning cycle in which the students were exposed to other group approaches in dealing with the PBL problems. The good internet connection available in the tutorial rooms was also used to the fullest and the students were encouraged to bring along their laptops during the group discussion. This approach allowed them to get quick access to the sources needed to deal with the PBL problems. In short, despite the relative lack of facilities from PBL learning environment perspectives, there is still a potential to create a PBL learning environment by manipulating the available facilities in the university.

For students to actively participate in the learning process, they were encouraged to take on different roles during the group discussion. The suggested roles included group leader, scribe, time keeper and ordinary group member. The group leader is responsible for general group management while the scribe is accounted for recording information during the discussion. The time keeper will keep an eye on the amount of time used for the discussion while the ordinary group member contributes to the learning process along with other group members. These group roles should not only be taken up by the group members responsibly, but they are also preferably rotated among the group members. Rotating the roles create an opportunity for each group member to contribute to the group in a different fashion. Explicit roles in group discussion also make the students more aware and motivated in what they should do for their groups.

Most of the students involved in the PBL design implementation were part-time students, which means that they were only within the university campus when attending classes that were normally held in the evening. In the morning, they teach at either primary or secondary schools. This particular background reflects the difficulty for them to meet outside class hours for group discussion. To address this issue, the PBL learning process/learning cycle was planned in a way that the group discussion should be accomplished before the end of the class time, and the students were required to divide the tasks before leaving the group discussion. This task division would be emphasised by the facilitators half an hour before the class ended so that the students leave the class with

a clear expectation on what they should do during the individual learning. This was to avoid any expectation in group discussion beyond the class time.

The initial findings on PBL design, which were derived from the first design phase, have provided sufficient cues on what kind of facilitations would correspond to the Malaysian teacher education, particularly by considering these three factors; the students' background (their bare exposure to PBL), the learning space in which the group discussion will take place, such as a big tutorial room and the need to implement PBL gradually.

The above aforementioned factors had led the researcher to adopt a floating style facilitation during the PBL design implementation. This style of facilitation involved the facilitators (in this case, the researcher and the local PBL practitioner) moving from one group to another to facilitate the group discussion. During the preliminary weeks of the PBL design implementation, a more guided and intense facilitation style was adopted in which each facilitator attended each group to facilitate (there were seven groups consisting of 5-6 students). Once the students got acquainted with the PBL learning style, the facilitation was made loose as the facilitators only attended the groups that needed more direction or groups that requested for further guidance. The facilitation was also made available beyond the class time/group discussion. This was particularly important for this research since the students involved were new to PBL and they needed continuous support. Hence, these students were encouraged to put forward their inquiries before or after the class time, during a set up meeting with the facilitators, during emailing and the use of social media such as Facebook and Skype. Therefore, despite an array of constraints, potentials are still there to create a conducive learning environment during PBL design implementation.

5.5 Revisit Research Question 4 (RQ4)

How do PBL design implementation impact the students´ learning and their learning environment?

The data collection and data analysis were administered in parallel with the PBL design implementation in UPSI. Both qualitative and quantitative data were collected to ascertain the impact of PBL design implementation on students´ learning and their learning environment. The qualitative data have provided rich descriptions while the quantitative data have served more general and superficial type of data for the aforementioned variables. An inductive analytical approach was used to analyse the qualitative data sources while descriptive statistics were used to analyse the quantitative data. The empirical research findings on the impact of PBL on student´ learning and students´ learning environment are reported as follows.

The students realized the knowledge and the variety of skills they acquired, developed and improved throughout the course. The PBL learning activities, including brainstorming, discussions, individual learning and resource locating were linked to their acquirement of such skills and competences, including the skills of communication, problem solving, self-directed learning, and critical and creative thinking. In fact, the group learning process has also enhanced their leadership skills, ability to cooperate, and information management skills. These garnered skills and competencies, according to the students, were applicable in their classroom practices and daily life.

Though PBL is a new learning environment to the students, the latter were optimistic and felt good about their learning experiences. The students had generally rated their high agreements on the three aspects of PBL: *the group learning process*, *the PBL task*, and *the facilitator*. From *the group learning process*'s perspectives, the students felt good getting help from other group members, and sharing the information with each other. From *the PBL task*'s perspectives, the students agreed that the tasks were clearly presented, provided with sufficient cues and stimulus, and able to promote self-study during the learning process. From *the facilitator*'s perspectives, the students had rated their high agreement on the commitment and knowledge of the facilitator. They were also

a strong agreement that the facilitator (1) had encouraged all members to participate, (2) helped them develop their reasoning skills, (3) intervened only when it is necessary, and (4) listened and responded well to their inquiries.

PBL was a challenging learning environment to the students. Despite variety of measures considered during the PBL design development and implementation, there were still three main challenges faced by the students during the implementation. The challenges were (1) the initial anxiety and tension among the students (individually and group) during the preliminary weeks of the implementation, (2) time insufficiency at various stages of the PBL learning cycle and (3) group issues. Reflecting on their learning process in PBL, the students confirmed that their group should adopt an effective group leadership, a better planning in their group timetable, a structured facilitation throughout the semester, and more directive and clear assessment methods.

5.6 Conclusions

This chapter specifically attends all the four research questions with each research question being revisited from different perspectives. As for the first research question, it was evident from the reviewed work that the PBL has been a successful approach in the Malaysian higher education context and in teacher education since it impacted positively from students' learning perspectives. The students of the Malaysian higher education and teacher education were aware about the knowledge, skills and competences they acquired after participating in a PBL learning environment. Consideration of potentials and constraints were made from the students' background, support from the university top management, student and academic staff's preparation and available facilities. This collective information have facilitated the researcher to develop the PBL design that emphasises on structured facilitation and an explicit PBL learning cycle.

As a design-oriented question, the second research question was answered from the methodological perspectives, from which the PBL design was suited to the Malaysian teacher education context. This was done by adopting Design Based Research (DBR) as the methodological approach. The DBR has emphasised on the local learning environment and contributed to a more practical and relevant classroom practice. This was achieved by allowing educational researchers to systematically design, implement

and evaluate a teaching and learning approach in a real-world setting. The PBL design did not exactly follow how it is originally planned, but it was rather subjected to change as the research and design progressed. Results from this researching practice has lead to the achievement of the PBL designs that are well suited to the Malaysian teacher education context.

The third research question enquired about the empirical potential and constraints of the PBL design implementation in the Malaysian teacher education context. Despite an array of constraints identified (such as lack of facilities and passive participation of students in group learning), there were still potentials to create a feasible PBL learning environment in the university. For example, the lack of facilities to conduct PBL can be attended by manipulating the existing facilities. In fact, the learning process can also be planned based on the facilities available. Lack of participation in group learning and unfamiliarity with PBL among students can be resolved by emphasizing on the roles of the group members during the discussions, and it can also be attended by a more structured facilitation during the preliminary weeks of PBL design implementation, and by including inter-group discussion sessions in the PBL learning cycles.

The fourth research questions evaluated the impact of PBL design implementation on the students´ learning and their learning environment. The PBL learning process was linked by the students to justify their acquired skills and competences such as communication, problem solving, self-directed learning, critical and creative thinking, leadership, ability to cooperate, and information management skills. From their agreement ratings on PBL aspects (that included the group learning process, the PBL task, and the facilitator), the students were generally optimist about their learning experience. However, there were still three apparent challenges faced by students during the PBL design implementation, which included (1) their anxiety during the preliminary weeks of the PBL design implementation, (2) time insufficiency at various stages of PBL learning cycle and (3) group issues. Reflecting on their learning process in PBL, the students confirmed that their group should adopt effective group leadership, better planning in their group timetable, structured facilitation throughout the semester, and more directive and clear assessment methods.

The abovementioned findings have spoken directly about the PBL design, teaching and learning activities, materials and systems. In fact, every finding in this research contributed to the fields of curriculum design, student-centred learning, teaching and learning in higher education and teacher education. Since this research has adopted DBR as the methodology, the rationale and contribution of the study were derived from the nature of DBR itself. Because this educational methodology is relatively new, translating it depends on the researcher's consideration. Hence, this research has translated the DBR methodology into three design phases: which are (1) Compiling Initial Findings for the PBL Design (2) Developing the PBL Designs for Malaysia Setting and (3) Implementing the PBL Designs in Malaysia Setting. Each phase embodies multiple elements of different types and levels– that represents a complex and interacting systems in efforts to understands how these elements function together to support learning. Across these phases, DBR has systematically manipulated the learning context to improve and generate evidence-based claims about learning by allowing rigorous and reflective inquiries to test and refine the PBL design. As a result, practical learning principles and theories that correspond to the local condition i.e. Malaysian teacher education are generated. Likewise, the research has fill in the gap in the academic literature of ´localising´ an innovative teaching and learning approach to ensure the impact on students´ learning and recognize the complexity of the learning sciences. As Lagemann (2002) argues, experimental control does not adequately explain learning as it actually occurs. Therefore, the DBR that simultaneously pursues the goals of developing effective learning environment is a way forward to explain the complexity of the learning sciences.

The research proposes several recommendations with regards to the introduction of the new learning practices such as the PBL, particularly in the context that is more devoted to the teacher-centred learning. To ease the transition to the student-centred learning, PBL introduction is needed. The PBL learning cycle (learning process conjectures) is developed in a way that corresponds to the students´ learning need and background, available facilities and facilitation style that collectively devoted to support student learning. In terms of product or design artefacts, this research has developed the PBL toolkit and the student guide to PBL. Similar to the PBL learning cycle (learning process conjectures), both the PBL toolkit and the PBL student guide were developed based on students, facilities and facilitation factors. The final design is derived from the enacted designs that have considered a variety of contextual elements. As a result, this research

has contributed in the development of the PBL design specific for Malaysia teacher education.

The mean of supporting the learning in this research was translated by identifying the potential and constraints of PBL design implementation. This information carry the expectation that the PBL design should function in a setting; thus, how such expectation are met or unmet is identified in order to refine the PBL design. This research has demonstrated how the local potentials were used to the fullest to support a student-centred learning environment such as PBL. In addition, this research proved that despite an array of constraints encountered in the local setting, they could be readdressed to create supporting elements for PBL design implementation. Therefore, establishing a new learning practice in a context that is entrenched with the traditional learning practice is possible. In doing so, DBR was considered a feasible means to initiate the change.

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Appendix A: Interview guide for PBL case at Aalborg University

Interviewee:

Date and time:

Venue:

Title: Students' Experience in PBL

Objective: To develop understanding of students´ experiences in PBL learning in terms of PBL learning process, group processing, perceptions about groups, facilitation, skills and competence gained and perspectives.

Sample: Six Mediology students in their first year of undergraduate studies.

Type of Interview: Semi-structured individual interviews.

The interview guide:

a. **Learning process**

i. Explain briefly what is your group action after getting the task/project?

ii. How do you divide the task among groups?

iii. Do you assign any specific role during the discussions?

iv. Do you use the project management tools (schedule, time line and etc) to manage your project? How do you see its advantages and disadvantages?

v. How long it takes for a discussion to finish?

b. **Group processing**

i. Do you have any specific rule to maintain smooth and effective group collaboration?

ii. How did your group maintain the motivation and engagement working on the project?

iii. Do you have any problems in collaborating with your group members?

iv. Is it easy to reach a consensus during group discussions?

c. **Opinion/perception about owns group**

i. How do you describe the group collaboration of your group after a semester?

ii. Do you see any advantages in learning through group collaboration?

iii. What is the drawback of learning through group collaboration?

_____

iv. Do you have any suggestion on how your group could collaborate better in the future?

_____

d. **Facilitation**

i. In average, how many times you meet with supervisor in a month?

_____

ii. Who initiate the meeting? Call from supervisor or its group decision to meet with the supervisor in particular time when you encounter problems?

_____

iii. Do you think you got sufficient guidance from your supervisors? If no, what do you need? If yes, please state it.

_____

iv. Which role do you think a supervisor should play to facilitate your learning?

_____

e. **Skill and competence gained**

i. After a semester experienced learning through group work, what are the skills and competence that you think you have gained?

_____

ii. Do you think you are now better equipped to work in group in next semester? Yes or no and why?

_____

f. **Perspectives**

i. Do you feel more comfortable now learning in collaborative groups than at the start of the semester? Why or why not?

_____

ii. Reflecting on the ways you work in group now, what are the things that you want to improve in yourself to be more competent in working in group?

_____

iii. How do you see the collaboration process relevant in your future undertakings?

_____

Appendix B: Interview transcript sample (PBL case at AAU)

CSST2_3_ Alexandr node

Time span	Transcripts
Node#1: Group processing	
[5:35,9 - 7:26,6] 4.26% Coverage	CS2_3: And also next...hmmm....we split the work, some people (group members) was making one task together, like two people dealing with the same tasks, some people will group together in three, so that is the way we cooperate in the group..and then actually we were like vote...who could do that, so for those who are volunteer to do the work, we write the task descriptions on the board, and first task..for example, dealing with Design, people will just..´ok I can do that´...and he or she will said.. ´who would like to join me?´..so the other person will said.. ´yeah I could help , we can work together´... R: So it is more on voluntary basis? CS2_3: Yes it is more on voluntary basis.. R: What about if you are good at particular things, let say if you are good at designing.. CS2_3: Ooo yeah, it is also through voting, so that those people will volunteer to do that...for other tasks, for example, if there is no body want to deal with that tasks, then we were like voting, but usually we had some guys who was good at writings, programming and making the design, so we had some people with various ability. R: What about you, you are good at what? CS2_3: I´m more incline to the ½design tasks, more like visual stuff..
[8:51,0 - 10:17,8] 3.34% Coverage	R: How long it takes for a discussion to finish? CS2_3: It is depend on which kind of discussions you are referring to, because sometime we had like the agreements...for example.. `I want to do that´ and somebody else were suggesting other things, and the....because 7 people in a group is quite a big group, R: Yes so that you will have 7 different ideas. CS2_3: Yes and for example if there nobody want to do that, and then..usually...yeah...if we had some disagreements, we will write all the brainstorming points on the whiteboard, forr example...yeah we are voting, each person should tell what he or she want to do, and to vote for each points, and which point got the most from the vote, we select them and we..yeah.. R: So that how do you find the solutions to divide the tasks? CS2_3: Yes, not just to argue, and wasting our time. R: So your group make it voting wat to select for the tasks for each person in the group? CS2_3: Ya... because arguing alone is not a solution, I guess. sometime it waste time.

Node#2: Roles in group	
Node#3: Project management tool and Pv course	
[7:36,4 - 8:51,0] 2.87% Coverage	R: Do you use the group management tool? CS2_3: Yeah, we use timetable, and other things..I do not know..like...we also have problem based learning course, we had different types on how to organizing our work... R: But in that PBL course, it will teach you on how to manage your projects? CS2_3: Yes..yes..we had the timetable... R. Ok your group have the timetable and timeline, but do you really follow them or meet the deadline that you set up before? CS2_3: We finished normally on time, we had the timetable, that timetable is only for us, it is not for the projects. R: Yes, that timetable is for your own group only? CS2_3: Yes, that is the purpose for our group only, and we can finish the task on time.
[10:19,6 - 11:48,6] 3.43% Coverage	R: Yeah...How do your group come with such ideas? CS2_3: It is from the course, from the problem based learning course. R: That is Pv course right? CS2_3: Yes, it is Pv course...but the problem was, I think this course should be made like....some lectures are a bit too late. For example. yeah..we handle the problems using our own approach..like..I do not know, maybe its human factor, and then we had this course on problem solving....that is suppose to be before, now.... Actually this lecture should be done before they are giving us the projects. Like how to form the group, how to choose your group members...I do not know why it is like that. R: But you already form your own group while listening to the lecture? CS2_3: Yeah...so didn´t understand why it is after the process that we already performed or did. Maybe it could give us some more help for motivation or knowledge or something like that, just to have this lecture before, like given us a project then...yeah we surprise...
[16:34,1 - 18:20,5] 4.10%	R: Do you have any specific rules to maintain an effective and smooth group collaborations in your group? CS2_3: Yes off course we have..we also have.....aaa during the Pv course, we had the lecture...that is really helpful for us..but also after...and we had the agreements coming or being the group room. We have to be here each day, like aaa...wiorking on the projects, and we had the discuss time sessions, when should we come everyday.. R: When should you come actually? CS2_3: It was 9 o ´clock during the morning, we were changing the time depending on the...if we had the lectures before or after...for each member. If, for example,

Coverage	somebody was late, or could not come, he could just write it (inform it) on Facebook group that we had, just inform that he cannot come, or he is sick, and aaa...so on. Also we had... R: Do you set up the rule in which you will impose a kind of punishment for those who are disobey? CS2_3: We had some kind of (punishment), but then we spoke with our supervisor and he tols us that it is not a good thing to have, but it was really like..hmm not the punishments, for example if a person was late, he could just buy a cake, for us to have lunch, or during the break, we also had coffee machine, and we will have the break with this cake. Ya it is not a punishment. But in a way, our supervisor suggest to us that we should not make any kind of action for that, just to...try to keep our schedule, and do what we suppose to do. R: So this is actually an oral agreements, you don´t put it in a paper? CS2_3: No no no...we do not put things formally.
Node#4: Challenges in Group Work	
[3:49,1 - 5:35,1] 4.08% Coverage	R: How do you start the discussions while getting the projects? CS2_3: We started like aaa....we do the brainstorming, discussions, and we made the timetable, but during the semester, actually we do not follow the timetable that we set up before, so we had the problems with that, because during this semester, a lot of people are sicks, they do not come or attend the school, because of the flu, live fever, and that was also the problems..and the... R: Is was true that they had fever or they just say it as the reason for not attending the group discussions? CS2_3: Yes, it was true..yeah...but in one particular week, we had one guy just....maybe he is a bit lying, or not telling the truth, but he was not coming here, and we had the issues because of that, because some people were telling...´ooo... we are all not together in the group, we should be together, and I do not want to work because he is not here, we are making the job for him´... and so on....because it is not fair..but later we decided that it is okay for him to work from home, if he doesn´t want or he cannot come to group room, he could do some works at his home, he must do that… so that is how do we handle this problems...
[18:11,1 - 22:51,6] 10.80% Coverage	R: So this is actually an oral agreements, you don´t put it in a paper? CS2_3: No no no...we do not put things formally. Also, we had the agreements, but we had some problems with that, because Mediology is the studies that mostly based on making computer games. And people who are studying it...so most of them are gamers, you know that gamers spend a lot of time playing the games, and on P0 projects, we do not have any problems with that, because all of us are working, but then in P1, in September, in every September, all the companies will release a lot new games, and its like a rule, every gamers should buy this game, so they are all buying because they are gamers, they really excited because this game release , all the Mediology group in Fb speaking about the games, so it is really a problems, I heard many groups have this problems.yeah...they started to play, so during the break, they started to play the games, so the break should be like one hour, but as they started to

	play the games, they are all became like 2 hours of break, sometime 3 hours, then we lost the time on that, so like I told you before, 1 person is sick, so he do not attend the group meetings, and the rest of the group members think that they should not work without these absent people, so they are not working, they are playing, just sit here and playing, and then me and some others guy are a little bit annoyed about that, because..ok we are coming here every morning at 9 or 10, and if there is nobody working, then we just waste the time because I´m not a gamer, I´m not playing the games, and i´m not interested actually. R: Is it majority of your group members do that? CS2_3: Yes, it is majority of them, or even from the Mediology course. Because Mediology is basically about the games, or making games. I was annoyed wit them because they are palying the game without doing nothing. It wasting our time,...and this is reason why do we not stick to our timetable, so lag behind maybe one and half week. Then we almost make the formal agreement to agree on that there is nobody is allowed to play the game in the group room, but we did not do that. We somehow manage to solve it without any formal agreement. R: So that was the main reason why you do not stick together in a group in the next P1 project? CS2_3: Yes, that is the main problems that we faced.
Node#5: Perception towards group work	
[26:14,0 - 27:14,2] 2.32% coverage	R: How do you describe your group collaboration after a semester? CS2_3: Hmm...It was not as good as like when it is at the beginning stage at P0, but we had some issues, yeah..but all in all, somehow we manage to...if everything is going nice, I think we should have the problems because it is all about problem based learning, all the education in this university based on this kind of learning, you must face the problems, you must find the solutions, how to solved it ,and continue...because it is a part of education.
Node#6: Perceived advantages	
[27:14,1 - 27:57,0] 1.65% Coverage	R: Do you see any advantages of learning through group work or group collaboration? CS2_3: You work with other people, and you see how they act in different situation, you can learn something from them, and teach them, both side... R: You can learn from your group members and the group members could learn from you? CS2_3: Ya, so the both side can take the advantages.
[37:51,0 - 38:37,0]	R: Do you think you are now better equipped to work or learn in the group in the next semester? CS2_3: Off course, definitely, but anyway we learn as we live, maybe in the next semester, new challenges will come up, and I will face other problems, it is the process of learning, when you face problems, and you will be more organize, as long

	as we live, we learn.
1.77%	R: Yes, because learning is a lifelong process...
Coverage	CS2_3: Yes, you cannot know everything in a time, we learn throughout your life.
Node#7: Perceived Disadvantages	
%	
Coverage	
Node#8: Commitment to Current Group	
%	
Coverage	
Node#9: Suggestion for a More Effective Group	
[28:44,4 - 30:21,7]	R: What about your suggestion on how to improve the group collaboration in your group?
	CS2_3: I think, the Pv course should be at the beginning, I think by this way, it would really help us.....when we need to...when we facing it, for me, (learning through group work) is new things. it is a question for the international students. For international students, at least for me, this problem based learning approach is new. But for the Danish students, it was ok because they had some previous courses on it, and also during their schooling years, they working in group, this kind of education is given to them in early age. And it was a kind of new to me, so I would recommend for the Pv
3.75%	lecture a little bit earlier.
Coverage	
Node#10: Dealing with Supervisor	
10.88%	R: In average, how many time your group meet with your supervisor in a month?
Coverage	CS2_3: First at the P0, the supervisor was telling us when to come and see him, what time that we can meet with him, so he was taking the action, but in P1, we were told that it is our job to write him and assign the...or tell him when do we want to meet, and then there is a week that he was telling us that, in fact he was telling all the group, because he told us..´I cannot come to the group room only for one group,because it is
[30:28,4 - 35:10,8]	long way for him to reach here´...He is also studying at the main campus, then we could speak with other group, whether it is possible for us to have meeting for a specific time, so that our supervisor could attend both groups in the same time frame. But aaa....we should collaborate, for example in a day, he could have group meeting with three different group. So he was kind like that. so were suggesting the date for him, during P1, we had less...in P0 we had one month, so in a month, we had 3 supervisor meetings, and during P1, we had maybe 4 or 5...
	R: So in P1, it is your group to initiate the meeting by suggesting the date of meetings to him?
	CS2_3: Yes, thats what we do. He was also suggesting time, so we could choose time

	that fit to our timetable, and we to discuss with other group as well before we are suggesting the date to him, so this is actually the collaboration between group to correspond to the supervisors´demand. R: Do you have to write or tell him beforehand on what are the things that you would like to discuss? CS2_3: Yes off course, owhh ya, I will tell you about that. He told us as well, for example, if he could´nt come on this or next week, he told us that we can easily write a letter, with the questions that we would like to ask, or the problems that we had, stuff like that. And he will reply to our email within 24 -36 hours. So I would say we had a very good supervisor. He also knew that we are the new studentns. So he is really helpful. R: So do you think you got sufficient guidance and facilitation from him? CS2_3: Yes, and the...what else...yeah..its ok...
Node#11: Perceived skills and competences gained	
[35:11,7 - 36:32,6] 3.12% Coverage	R: After a semester experience learning through group work, what kind of skills and competences that you think you had gained? CS2_3: I think I learn how to manage and solve the problems, how to face it and then find the solutions. Also how to work with different people, how to react and sometimes it is just better to...like..it depend on the situations..when you can suggest something, or when you can listen and learn of what other person is telling you. If he is sure he is correct, then... R: So now you know when is the correct time to suggest, when is the time that you just listen...
Node#12: Improving self and the group process	
[38:38,4 - 41:56,4] 7.63% Coverage	R: Reflecting on the way your work in your group now, what are the things that you want to improve in your self to be better contribute in your groups? CS2_3: I should improve...hmm...its very hard to tell about your self, because usually the other people could tell more about ourself, like I cannot say any bad things about myself. But yeah...I should improve in many things.. R: But do you have in your minds that you think you can improve things when you go to the next level? I mean you do not always perceive your self as the best right? CS2_3: No..no... I never do that. also I really like when people are telling me or report to me, for example, I should not do that, they are suggesting to me and telling me why they do not allowed me to do that anymore. Or if I done something wrong, they tell me. R: So you can receive all that kind of critics? CS2_3: Yes critics,and I actually like to recieve critics, because I´m a kind of person that will act normally and the...ok it is a critics, but then you can see what you did wrong, i do not know, its depend, but usually..yeah its really a good point somebody tells you, or critics you. And in PBL off course, we had to give suggestions to have the

	´hot chair´, in every two weeks, in which each person in the group will sit on the chair, and the rest of the group members will tell about, what he does like about him, what he doesn´t like him, the way how he works. And the person sit on the hot chair should not replt at all, he just listen, we had the course about that. R: So do you do that in your group? CS2_3: No, we perceived it as a bad thing. I do not know why. But for some group, it is useful for them.
Node#13: Relevant of group work experience	
[42:12,2 - 43:08,3] 2.16% Coverage	R:How do you see the collaboration process is relevant to your future undertakings? CS2_3: Yes off course, it useful and it is also a part of future life. Because we will collaobrate and we will work with other people, and we always communicating and it helps you a lot not only in your study, but also in your personal life, in your work. R: So you are expecting that this kind of skills are... CS2_3: Yes, it is very useful and it will help me in the future undertakings. R: Both in your professional and personal life? CS2_3: Yes definitely.
Node#14: Sustaining motivation and engagements	
[22:51,6 - 26:10,7] 7.67% Coverage	R: So how do you motivate your group? I mean to motivate your group members, to keep on doing this work, this is important...or how do you sustain the engagements? CS2_3: The motivation was..if we do not finish to do the work,if we do not stick to the plan, we can failed, I heard that for Danish students, as they get the SU, the money from the governments, they become really motivated because they get money monthly, and if they do not pass or failed for the exams, the SU will not continue, or they even could be expelled from the university. I´m not sure about that, but I heard it from Danish students. They also need to repay all the money they got from the Government if they do not perform. I think it is a good motivations to work hard and excel, because they get the money, so you are easily pay your bills, do the studies, so you should studies. In Lithuania, you will get the money from the Government if you are excel in the course, but it is only for small number of receiver, but the money you get, it is not even enough to pay your rent. R: So it is not so much compare to here? CS2_3: Owhh ya...I think they got around 600euro. So its quite a lot. R: So that is for their motivation, so what about you? CS2_3: The motivation for me was not to fail. Because, come on...you came here to a foreign country, just to study, not to waste the time, and then I could easily just play games or do nothing back in my own country, and see all my friends, and live with my family...

Appendix C: Group process analysis report sample

Process analysis of group A221

Quang The Nhat Mai
Jakob Klingberg Kruhøffer
Casper Madsen
Andrei-Vlad Constantin
Christoffer Schandorff
Simon Hansen
Lasse Emil Jensen

Project Management

Description
In the beginning of the P0 project, group A221 brainstormed their ideas for the problem statement. Initially, the group very ambitious goals of creating a compilation of several smaller games into one game, but after a few days, the goal was quickly reduced into a more smaller and realistic one.
The decisions that were made in the group were decided in a democratic manner- it all came down to the majority votes of a proposed idea.
Also, the group made a time-schedule and after that all of the members were given a certain task to complete."Dropbox" was a program that was used to share documents and codes created during the game making process among the group members. It served as a great asset in the distributing the different parts of the game within the group.

Assessment
The group did not have any major problems during the decision making process. There were neither real arguments nor tension within the group during the game making process. Everything went smoothly when it came to making decisions and finally implementing them.

Analysis
Since most the members were somewhat self-disciplined, many of the given tasks were completed within the given time. It was also decided that the workload was spread among all the members so that everyone had a role in the making of the game. All of the members all worked hard to complete their share and the game was successfully completed in the end. When someone in the group had a problem in which they could not fix, the other group members offered a helping hand.

Synthesis
For the future P1 project, we aim to use the same organization skills like earlier, for example, making deadlines for completing different components of the game from the beginning. Also better management of time for the various tasks handed out.
The writing of the report shall be started earlier, since it has been demonstrated that starting the report after finishing the game was not a good idea.

Group Collaboration

Description
The collaboration was very good throughout the work process. The members respected each

others wishes, expectations and background.
After the first meeting, the group just started knowing each other better due to the similarities of interest (i.e gaming). After the first week, the group started getting along better, and furthermore the events organized by the university facilitated this process.
It was agreed to meet at the group room everyday at 10 am, excluding for days where there were meetings with the supervisor. Absences or late comings were usually for good reason and there were no real issues.

Assessment
Group collaboration was not an issue for group A221 during the P0. Everything went very smoothly from this point of view.

Analysis
The best thing about our group during P0 was that although we were very different one from another, we still managed to have a very balanced team. Our communication was very good, we understood each other well. Decisions were taken without too much of a fuss, because the team was that well made and our goals were well understood by everyone.

Synthesis
The best method for improving the group performance, to our experience, was by having the members being involved in some form of group activity (i.e parties, LAN parties) which allowed better understanding amongst the members and strengthened the bonds of the group. It is also very important to assert ones opinion rather than remain discreet, disagree and hold grudges on the others.
The mutual understanding of the group members, we believe, will prove imperative for group's success.

Collaboration with supervisor

Description
The group only had two meetings scheduled with the supervisor. Considering the difficulty of the P0 project, our team did not have many questions for the supervisor. We only asked him about details on the exam, presentation and the report structure, rather than the game itself.
We always had an agenda of topics for our supervisor meetings, so everything went smoothly in this area too.

Assessment
Although our supervisor had some pressure on him due to his plans outside of our group, we managed to make use of his supervision effectively. We did not have many questions and he did not have much time, so this balanced out positively.

Analysis
As stated before, our supervisor had limited time available to supervise us, but it worked out for the best. Other than that, there were not any problems regarding the meetings. The topics chosen were always solved in less than the time allotted.

Synthesis
The most important thing to consider about supervisor meetings and the supervisor, in general, is to ask him about anything the team needs to know. This is because he is obliged to help you. Just keep in mind what the group needs in terms of information and decide if it is worth asking, then add that to the agenda for the meeting or not.

Appendix D: Individual and group written reflection prompt

1. Individual Written Reflection Prompt

(a) Reflection on the topic

i. Briefly explain what do you have learned today *(Secara ringkas, huraikan apa yang telah anda pelajari hari ini?)*

_____

ii. What was the most important thing you learn in today's session? *(Apakah kandungan yang paling penting yang anda telah pelajari pada hari ini?)*

_____

iii. What questions or enquiry do you have from today's session that remains unanswered? *(Apakah ada sebarang soalan atau pertanyaan yang masih belum dijawab dalam sesi hari ini?*

_____

(b) Reflection on the learning process

i. Describe your role in the group discussion and how you felt about it *(Huraikan peranan anda dalam perbincangan hari ini dan apakah perasaan anda?)*

_____

ii. Does your group collaborate well? All members contribute equally during the discussions? Elaborate on your responses *(Adakah kumpulan awan bekerjasama dengan baik? Semua ahli kumpulan menyumbang idea? Huraikan jawapan anda)*

_____

(c) Reflection on self-directed learning (individual study)

For each of the group members, answers the following questions

i. Describe the task given to you
ii. What resources do you approach to deal with the task?
iii. Do you have any problems to find the resources?
iv. Do you have any prior preparation for todays´ discussions?

Member 1:

_____

_____

Member 2:

Member 3:

Member 4:

Member 5:

(d). Final individual written reflection

1. What were the issues, frustration, or difficulties that you faced when participating in the PBL task?

2. Do you recommend that PBL be used in this course next semester? Why and why not?

3. What suggestion or improvement would you recommend o improve the PBL sessions?

2. Group Written Reflection Prompt

(a). Briefly descripts what was the main ideas discussed in today´s group discussion. What were the suggestions? What decision were made and why? Do reflect on these decisions. Were there good ones? Why or why not? What reservations does your group have? *(Huraikan apakah idea idea utama yang telah anda bincangkan di dalam kumpulan: Apakah cadangan yang telah diutarakan? Apa keputusan yang telah dibuat dan mengapa? Buat refleksi untuk setiap keputusan: Adakah ianya keputusan yang baik? Kenapa dan kenapa tidak? Apakah isu atau kandungan yang masih kumpulan anda tidak pasti setelah selesai perbincangan?)*

_____

_____

(b) To answer the reflection fully, it is recommended for you to retrospect your last week´s group discussion activity and your individual studies for a week.

Reflection on last week´s group discussions

i. Briefly explain how your group starts the discussions?

_____

ii. Is there any strategy adopted to enhanced group discussions?

_____

iii. What is your suggestion to make your group discussion more efficient and effective?

_____

(c) Reflection on the PBL tasks

To answer the reflection fully, it is recommended for you to retrospect about all the three PBL sessions that you have worked on as a group.

a. First PBL session was on *constructivism* in which you were asked to evaluate a teaching and learning session from a video by developing an evaluation tool as one of the group deliverables.

i. To what extend is your group motivated by the scenario in initiating the discussions?

_____

_____

ii. Your group was given 3 weeks to complete the task (1st week: clarifying the scenario and generating learning issues, 2nd week: 2nd group discussion to improvise the evaluation tool and 3rd week: group presentations). Do you think you have sufficient time? Is it worthwhile to invest such amount of time to deal with the task?

_____

_____

iii. Do you get sufficient facilitation from the facilitators to deal with the task?

_____

_____

iv. Do you think your group has addressed all the learning issues?

_____

_____

v. How do you find the relevancy of the task to your current practice?

_____

_____

b. Second PBL session was on *alternative conception* in which you were given a letter from a journal publisher inviting you to publish a review article. Review article on alternative conception in specific topic in science learning serve as your group deliverables.

i. To what extend is your group motivated by the scenario in initiating the discussions?

_____

_____

ii. Your group was given 3 weeks to complete the task (1st week: clarifying the scenario and generating learning issues, 2nd week: Compiling the information and preliminary outline of the articles and 3rd week: Finalize the format and submission). Do you think you have sufficient time? Is it worthwhile to invest such amount of time to deal with the task?

_____

_____

iii. Do you get sufficient facilitation from the facilitators to deal with the task?

_____

_____

iv. Do you think your group has addressed all the learning issues?

_____

_____

v. How do you find the relevancy of the task to your current practice?

_____

_____

c. Third PBL session was on *21st century learning* in which you were given a poster from a laboratory design company held a competition to design a 21st century science laboratory. Central tenets of 21st century learning and layout of the science laboratory serve as your group deliverables.

i. To what extend is your group motivated by the scenario in initiating the discussions?

_____

_____

Your group was given 1week to complete the task (1st week: clarifying the scenario and generating learning issues, 2nd week: Group presentation on the laboratory layout). Do you think you have sufficient time? Is it worthwhile to invest such amount of time to deal with the task?

_____

_____

ii. Do you get sufficient facilitation from the facilitators to deal with the task?

_____

_____

iii. Do you think your group has addressed all the learning issues?

_____

_____

iv. How do you find the relevancy of the task to your current practice?

_____

Appendix E: Interview guide for PBL design implementation in Malaysia

Interviewee:
Date and time:
Venue:

Expected number of participants: 7 participants (representative from each group)

Date to execute the interview : 22-25th May 2012

a. Background

i. Do you have experience with working in groups in your previous studies (how assignments/projects – duration – group size)?If yes, how it differ or similar to the current group collaboration? If no, what is your first impression of group work (strengths/weaknesses)?

_____

ii. How would you describe the difference between project-work compared to the lectures?

_____

iii. What kind of skills do you think is important to work in a group environment?

_____

b. Group processing

v. Do you have any specific rule to maintain smooth and effective group collaboration?

_____

vi. How did your group maintain the motivation and engagement working on the project?

_____

vii. Do you have any problems in collaborating with your group members?

_____

viii. Is it easy to reach a consensus during group discussions?

_____

c. Learning process

i. Explain briefly what is your group action after getting the task/project?

_____

ii. How do you divide the task among groups?

_____

iii. Do you assign any specific role during the discussions?

_____

ix. Explain briefly what are you doing during your individual studies?

_____

x. After a week of individual studies, you will report your individual studies outcome in the next group discussions. Usually what were expected from each group?

_____

d. Opinion/perception about owns group

v. How do you describe the group collaboration of your group after a semester?

_____

vi. Do you see any advantages in learning through group collaboration?

_____

vii. What is the drawback of learning through group collaboration?

_____

viii. Do you have any suggestion on how your group could collaborate better in the future?

_____

e. **Skill and competence gained**

iii. After a semester experienced learning through group work, what are the skills and competence that you think you have gained?

_____

f. **Perspectives**

iv. Do you feel more comfortable now learning in collaborative groups than at the start of the semester? Why or why not?

_____

v. Reflecting on the ways you work in group now, what are the things that you want to improve in yourself to be more competent in working in group?

_____

vi. How do you see the collaboration process relevant in your current profession as a teacher?

_____

Appendix F: Interview transcript sample (PBL design implementation in Malaysia)

Interview Transcript for ES_1_ Arasu

R:Thank you so much on your willingness to participate in this interview, so that through out the interview I will recorded it using this voice recorder in order for me to transcribe and to interpret it in later stage of my studies , and this interview is merely of my research, so your responses to the questions that I´m going to ask you will not influences the marks or the grades for the Dr Sopia course and I would like to suggest to you to give me transparent and honest answers. So what ever it is (your answers) just express them although it is not something that I like and you can even critics me. So the purpose of the interview is for me to know about the group processing (what is happening in your group), learning process occurred, your opinions and perceptions about your own group and the skills and competences that you gained by from learning through PBL way and also some perspective questions. Alright so can you tell me a bit with your educational background.

ES1: Hmmm… I´m actually a paramedic for 10 years, assistant for the doctors and then after that, I don't like because of the paranoid, I´m paranoid to any surgery… then I want to continue my studies in pure Biology fields…I finished my first degree in UKM..and then after that I backed again to hospital and I was lecturing in Anatomy and Physiology..and then after that I took KPLI because they said KPLI can be even apply in Medical field..just they want skills of teaching you know….. Once I applied KPLI ….I got it… and I did my KPLI in MPPP…After finished my KPLI, then they posted me to Sungai Buloh Hospital as a lecturer in anatomy and Physiology for medical students..and then I my husband dislike my job and my children is very small…so what I did I went to KPM whether I can convert my service to become a normal teacher ….so in that particular time the PPSMI policy is still there..so they really wanted …they said ok, within a week I got the offer letter and they employed me as a Biology teacher and I backed to Ipoh again

R: So now you are teaching in Ipoh?

ES1: Yes in SMK Sungai Pari
R: So you are teaching only Biology or any other subjects as well?
ES1: Biology and Science
R: Right…looking at your educational background, you come from the medical fields right? So did you familiar with learning through group work because actually PBL is originated from medical education at McMaster University, Canada
ES1: Actually when I was a paramedic…mean after I finished my Diploma, during my diploma education, always they emphasize on group work ….but when I went for my first degree studies, very hardly I seen group working in UKM… I don't know..maybe in 3 years once or twice we do the group working…so the rest is all individual working…but after I came as a Master student here in UPSI, I would say its 90% groupworking… I feel group working is better because in individual you only by your own self, you only evaluate your own ideas, and you are only get your own ideas and do not mixed with other friends….its always your own opinions
R: So while doing your Masters now, most of the courses are emphasize on collaborative group work, but it is not necessarily PBL?
ES1: It is PBL also, we are given the PBL scenario and search for the learning issues like Dr Sadiah´s class (Assessment in Biology) and 100% is all about PBL you know…
R: So that course is in this semester?
ES1: Yes in this semester
R: What about last semester?
ES1: Last semester…so far no….ooo yes for last semester, it was with Dr Mai Shihah class…She gave us a title and she did asked her to look for everything …we have to do all like a thesis…critique journal and all of that with our own self
R: Ok aaa…. So it is also collaborative work?ES1: Yes it is also collaborative work…100%

R: So there is no individual assessment?

ES1: No, there is no individual assessments…but she has given some kind of quiz that is only 5% weightage
R: So how you would describe differences between PBL or collaborative learning with the lectures?
ES1: Collaborative learning like in Dr Mai class...sometime we faced group members...I´m talking about disadvantages...if you are good at English, they will ask you to do thing like more to Discussions, you know..thing like that….its problems to me,..I´m facing that problems…I mean like I have to do things…
R: But its good right because it can increase your strength?
ES1: Yaa… my strength is increased…but…that is whay I take it in positive ways…I do not mind…now don´t care…while dividing the tasks…ok you take this part…
R: Is it something related to English?
ES1: Yes, because I can create things…they do not want to take that tasks (related to the use of English language)…they feel it is difficult to them… so I´m a but disappointed…but err…I think sometime when you give collaborative group working, I think as a lecturer you should give at least 20% individual working, then only you can assess the individual parts…otherwise when we have complaint about our group members..you see…..so its very difficult….
R: Is it because of the free riders in the group?
ES1: Hmmm…aaa… Yes, so I think you should also give individual assessments and things like that you know….
R: Yaa.ya…yes yes….
ES1: To evaluate the person (individually)…
R: Yes, I also do not think it is a good idea to rely 100% on the group assessments…it is not fair
ES1: Yes.. it is not fair
R: We also need the individual assessments…and we still need it
ES1: But the… Dr Mai gives 100% for the group assessments..So its very…this thing…so as for my self, I ended up journal reviews…Chapter 2 literature review and critique I also have to critique because they are not so good in English..so they always pass it to me…you know they are my friends…
R: But don´t you think this is not a good way to divide the tasks…because they know your strength…what about them? If they do not do the task,
ES1: Some think like that, but I do not want…you know… I will go tell to that person that I do want it to be like that…my husband told me, take it in positive way with these…but this is not in our group now (in the current class)…. Our group is ok, every members of my group are excellent…I can say that…and everyone participate…everyone is equally good you know….like Faizah is very good..Elil is good…Deviki is also good…so 100% we are able to to our work in group…I´m very happy with this group…..this is an advantages of group work…you know..some..in a passive group..they will push you…ok you do the Discussion (part)..and Conclusion part…thwy won´t do (that part)…They will deal with Introduction..Methodology…and they said…you are good in English…so do the Critics parts….I´m facing that..and if you do not want to do that, they will boycott you….this happened last semester…so I have to keep moving..because we need friends in collaborative work…my husband said..you want to be clever….
R: Yes, take it in positive way…
ES1: So what kind of skills kind of skills do you think is important to work in a group environment?
R: of cause...in a group…you must look for the sources…some students they do not look for sources…just depend on two or three sources… I don´t think so…you must have many sources…skills in searching for the (relevant) sources….and then you must have skills to ….Discipline…discipline aaa….sometime you must be very punctual…..meet at 4pm….but they won´t come…then they will come at 8pm during the evening….ok they divide the task before…I have to do discussions..conclusions..finished (I completed my work)….but when they come to library…then only they do
the discussions and conclusion compiling….my work is finished…when they see you free…they said…hey come on…you do this,,,you finish this part…so I got through that…that is really come from my heart la…I tell you….ok then they said..we divide our task again lah…for my self, I like to finish in time….I don't like to delay my work…so when I come to the library…they ask me to do other unfinished work…..
R: But you set up the deadline (to compile the works among your group members)?

ES1: It is difficult…especially the men, so it can create misunderstanding….so what I do sometime I purposely came late and let them started off the discussions…Sometime I finished the task already…then I called one of them and said…hey I still not finish my work..I will come late..it is so difficult to complete..so I lie to them…A lot of things to do la…Actually I´m taking four courses this semester….but it is ok because it is not exam oriented courses…all of these courses are project-based…so I can do it….so basically I will sleep around 2 to 3am in the early morning to do my assignments…
R: So all of these courses do not have final examinations?
ES1: only one course which is Assessment in Biology…20% for final examinations…Before Thursday I must finished all the tasks…so…I do that…I will put the schedule like this…Monday must finished this..before Thursday I must finish
R: Refer to your own group in our courses, do you have any specific rule to maintain smooth and effective group collaboration?
ES1: emmm…if you talk about smooth aaa… we have to stay in one place lah..so that it would be easier..other than that…strength and all of this thing is very good …I got no comments…since we are far, what we do is once we finished to do the tasks, we will email to each of uor group members…the next day we will get the feedback from each of our group members…so I feel so enjoyed working in this group..
R: So there is no specific rule….what about the setting of the deadline?
ES1: So far….my group is very excellence…so no comments…ok we said..Elil said before Thursday night I want everything…so we submit our work to her on Wednesday night…we send it to her when it is her turn to compile our group work…If i´m the one who is compiling the work, then they will send it to me..so before Thursday, we are almost done with our work..so there is no delay..let say if Faizah is not well (since she is pregnant)…we will do the work on behalf of her..and she will do the compiling tasks since it is easy for her…
R: So that is why she is the one who is always submit the work from your group to me?
ES1: Aaa…. We do like that…
R: But Elil is the one who compile all the tasks from the rest of the group members?
ES1: Hmm…Elil and my self will compile…
R: How did your group maintain the motivation and engagement working on the tasks?
ES1: Is it to maintain the motivation?
R: Yaa…because maybe some of your group members feel depress because there is many thing to do….
ES1: Until now we never feel bad in the class..the only thing is about the recent PBL tasks….to developed the layout plan for 21st century school science laboratory… it is a bit difficult…how to create and then lastly we got journal on that, and we share among the group members and we choose one of the journals….and then from there we create our solutions…So it is a bit late (compared to our performance in previous tasks)…then Elil said No….we will make introduction using music from picasa…we give a little shock to Dr Sopia…do something different…and then we did the powerpoint for our presentations ……
R. So there is no serious depression occurred among group members?
ES1: So far no..that is why I said we are all understand to each other and matured (enough) in that group and we are really workaholic I can say…other group also said that I´m workaholic…that is I told you the advantages of this group….They push the things together…but of course learning through group work has some disadvantages…students need to be assess individually…I think we should give 20% of the assessment for individual assessments/work…
R: Do you have any problems in collaborating with your group members?
ES1: No, no problem at all
R: During the discussions, is it eady for your group to reach the consensus?
ES1: Yes, because all of them are good in English….so no problem you know…
R: I mean each of you have your own task?
ES1: Yes, since we already divided the tasks what each of us need to do, so there is nothing to argue for…
R: No, I mean before your group can come out with the Learning Issues, you need to discuss with them, then each of you have your own opinions and ideas about things right? So maybe there are some arguments happened during the group discussions? So how does your group come with the conclusion to reach the consensus?

ES1: Hmmm…aaa…. When we creating learning issues, we contemplating…this (ideas) is suitable…We do it in fun ways….
R: But finally you can reach the consensus?
ES1: Sure, reach the things..some more we will have continuity to finished the work…we feel a bit difficult to create Learning Issues, but then,…the Learning Issues should be in the long sentences or short sentences..that way, we had the problems..but actually only four (4) wife and one (1) husband…Dr Sopia said…then we understood…as long as the question (inquiry is there)….
R: Can you explain briefly what is your group actions after getting the task/project?
ES1: First thing we will divide the tasks, …ok first thing we willsee …what we are suppose to look on it, what we are supposed to do…then we will determine is it relevant or not…then from there we will say …then when you (me) or Dr Sopia passed by, and we will identify what are the thing that we had to do, then we will divide the task equally…
R: Ok…it is all about your FILA chart?
ES1: Yes FILA chart….
R: I mean in your Action Plan column, you need to make it explicit how do you divide the tasks?
ES1: Yes..yes….
R: So is it helpful for you to used that FILA chart to articulate the thinking process in your group?
ES1: Learning Issues is good (in FILA chart), you know…through the learning issues, we can asked questions…without Learning Issues (column), I feel aaa…we are asking many questions…actually you are digging a lot of things…
R: Ya..ya..this is actually the purpose of Learning Issues…
ES1: Digging..and digging…through that I think you can write and inquire a lot of things…that's I came to know la….I mean..after I came through this learning process, there is FILA chart…
R: But it is not easy right?
ES1: Yes, at first it is not easy, that is why I said when..for the Ideas and Fact is easy..but when it come to Learning Issues…all the head will down…then we come to Dr Sopia…. I like the way she mould the questions…We ask whether our questions in Learning Issues is correct or not, then we will call you…Termizi..Termizi…but you are busy behind….you call Dr Sopia….
R: How do you divide the tasks among the group members?
ES1: Hmmm…
R: Is it depending on the personal strength?
ES1: No..no..no…in my group we never do that..so we just sit and…there is one time we do the voting way to divide the task among group members…Ok, who is the leader…ok its me…my self is in charge…ok we put the name in the sequence (Arasu, Elil, Faizah and Deviki)…so according to the sequence of Learning Issues, we will take up the tasks…in this example, Arasu will be responsible for the 1st learning issues…we don´t say like…ok you did that..ok you did this….for example…in methodology part (in the article writing tasks)…. I´m the one who is responsible for this part…but I didn´t get the proper methodology…So I sms one of my group members (Elil), I told her that I didi not get a proper journal (articles) about the methodology part…it is not so clear in terms of methodology…then Elil send to me few journal articles…so we exchange the information….let say if we are lack of something..we will do it in that way…
R: So during the discussions, do you assign any specific role…I mean…for this time around (discussions)….you will be the leader….you will be the time keeper
ES1: Yes, we already set up that…I was the leader for most of the discussions… I´m the leader for the first task…seconds task was lead by the Faizah..the third PBL tasks was lead by Elil….
R: So you rotate the roles among the group member…
ES1: Yes, we did rotate the roles….
R: So what about the scriber role? Or all of you are doing the writing part?....
ES1: In final tasks, Deviki took the role as a scriber, in first and second task, it is Faizah as the scriber as she can type quite fast..so we let her do the type things…
R: So you still used that kind of role?
ES1: Hmmm….yes,so everybody…

R: Because before this I interviewed some of your group members..no, not your group members…they said they do not employed any rules during the discussions
ES1: ooo..cannot like that…
R: So I think it is systematic for you to do that…So you still adopt that kind of role until the third problem scenario?
ES1: Yes..yes..we still do…
R: Can you explain briefly what are you doing during your individual studies? Do you know what do I mean by individual studies?
ES1: What do you mean?
R: I mean after you finished the discussions, and finish the class, you already divided the tasks, go back home, and what are you doing during that time?
ES1: Ya… I put the time, as what I told you earlier, I set up the date…let say Monday I finished this course assignments, so in Tuesday I will deal with assignments from other courses, so in Monday I have to look for the sources and roughly I´m done in searching for the sources in Monday….so next day..let say if I´m doing another tasks, once I finished, I revise and try to complete it…
R: So when looking for the resources, mainly you will use the internet?
ES1: Of cause I´m using internet…
R: Do you the library?
ES1: Ya..I came here 2 times, I´m searching for the thesis examples…
R: So mainly the way you find the resources is from the internet?
ES1: Internet..yes…
R: Right, after a week of individual studies, because in our class, after your got the problem scenario, in the week after you will do the second discussions …so that when you come to the second discussions, do you asked your group members to come out with something..I mean some written notes, what they are doing during the individual studies period…
ES1: They brought their……like in the journal review tasks…everyone of us brought their own work already…everyone of us got the sources..so when we come to the class, we sit together and then we said…what do you have…then we compile the sources, and mould it again…
R: So when you come to the next discussions, it is more on compiling for the sources…
ES1: We are finished our task in time….
R: How do you describe the collaboration of your group after a semester….because it is the same group throughout the semester…so how would you describe it generally?
ES1: I think I´m enjoyed with the group…
R: So if you have the opportunity to…
ES1: Yes, I would like to be with them again in the next semester …but they are senior you know..they are about to finished up their studies…they are 1 semester earlier than mine…
R: Do you see any advantages in learning through group collaborations?
ES1: Individual learning focused on our own ideas, then in group…during we……I mean when bring our own ideas, our group members can commented on it…if you are individual, no body to comments, and you feel that is the right things, so there is where collaborative is good..
R: So you did see the advantages more on sharing the ideas
ES1: Yes, sharing the knowledge, commented on each other, sometimes our ideas is not perfect, somehow it is sure there is mistakes…so I think group work is very good…but in certain group, not in the lousy group
R: Yes, you did experienced both …..So did you see any other advantages?
ES1: If it is an efficient group, they will look for the resources very fast, and finished up the task very fast, you can save the time,
R: What about the drawbacks of learning through group work?
ES1: So far in current group, I do not have any issues, but that is why I said…by allocating 100% of marks on group marks… I do not agreed with that, at least 20% should be allocated for individual assessments. We do not know the particular persons working or not, even if you are asking for peer evaluation,the peer evaluation among ourself also cannot give…let say…what ever you write, show it to me first (in the peer

evaluations)…so we do not want to misunderstand to each other, so better give 10% for individual assessments…
R: So although it is a group work, still…
ES1: Need the individual assessments…
R: So that is one of the disadvantages of group work..hmmm…do you have any suggestions on how your group colud collaborate better in the future? I know they are very good now, but perhaps there are some rooms for improvements?
ES1: In our assignment for drawing the plan for the 21st century labs, I feel that our drawings is better if we have the skills in AUTOCAD..I can feel it…In fact, I asked my husband to do it for me…then my husband said..ooo my god, you want to use AUTOCAD? Please la…don´t la…. I got no time…so we did it normally…
R: Right, after a semester experiencing the PBL or learning through group work, what are skills and competences that you think that you have gained?
ES1: Hmmm… I´m more confident…and I know how to create the Learning Issues, in a right way…and then, i´m…because Dr Sopia..she accept critics… so in that way, I don´t feel any barrier to talk to her, I can give my views..points… I´m quite happy with the…I mean the way she conduct the class..like some lecturers, they do not like us to argues… but Dr Sopia not like that..she accept every point and then she know how to upgraded the ideas we express….just like….not this way..she put in in this way…so I like the way… We also feel more brave…let say, if we have to critics, so i´m the first person to talk…
R: So in our class, it always the person to give feedbacks and comments…
ES1: I think it is related to the language…maybe they feel inferior…
R: But as for me, I wouldn´t mind if they want to express it in Bahasa…
ES1: My suggestion for the language barriers is to mixed up students in the groups… We have to mix Malay and Indian…. So that those who is not speak in English will have to speak in English…..
You see.. When I´m a teacher, I was previously in Anderson you know… 80% are passed (in Biology), and 20% are fails and all of them are Malays…So I would suggest you are the who created the groups… must have mixed races… and then for the presentations, it must be in English…. So they will talk in English….
R: I only came to your class in 5th week, so I do not know how you choose your group members, because it is already created…
ES1: Yes, we divide among our self, and Dr Sopia do not say anything on it….So in the future, please mixed up the groups…. When we have mixed race, the ideas is different…you can get different ideas…
R: Do feel more comfortable now learning in collaborative group compared to at the start of the semester?
ES1: Yes..yes… I feel more confident…
R: Reflecting on the ways you work in the group now, what are the things that you want to improve in your self to be more competent in working in group?
ES1: Hmmm….let see, beginning of the semester, I mean in my previous studies…We were given a module at the beginning of the semester…. So we know that we need this specific kind of knowledge…so when I come to the class, I already have the knowledge…So what I mean is that I put more input… prior knowledge in managing in science courses is poor…. Because we do not exactly the content of this course…. when give the task..at that time,only I look for it…so I ended up with some problems la…
R: How do you see the collaboration process is relevant in your current profession as a teacher?
ES1: Hmm…. As a teacher..yes..relevant…group working can be implemented in the class, like for example, the FILA chart ….it is really can helpful..but I didn't start yet….because we are short of time, even when I have the extra class…
R: So you have the intention to employed PBL in your own class?
ES1: Yes, but in the extra classes….I just want to try it out… just give students some tasks like in Nutrition topics, and ask them to elaborate…

Appendix G: SPSS-generated output for the Cronbach alpha value

```
GET
  FILE='\\PLAN.AAU.DK\Users\borhan\Documents\SPSS n Nvivo\pilot
study.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
RELIABILITY
  /VARIABLES=Gla Glb Glc Gld Gle Glf LPa LPb LPc LPd LPe LPf LPg PBLPa
PBLPb PBLPc PBLPd PBLTa PBLTb PBLTc PBLTd PBLTe Fa Fb Fc Fd Fe Ff Fg
  /SCALE('ALL VARIABLES') ALL
  /MODEL=ALPHA.
```

Reliability

Notes

Output Created		06-OCT-2013 12:53:28
Comments		
Input	Data	\\PLAN.AAU.DK\Users\borhan\Documents\SPSS n Nvivo\pilot study.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	7
	Matrix Input	\\PLAN.AAU.DK\Users\borhan\Documents\SPSS n Nvivo\pilot study.sav
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.
Syntax		RELIABILITY /VARIABLES=Gla Glb Glc Gld Gle Glf LPa LPb LPc LPd LPe LPf LPg PBLPa PBLPb PBLPc PBLPd PBLTa PBLTb PBLTc PBLTd PBLTe Fa Fb Fc Fd Fe Ff Fg /SCALE('ALL VARIABLES') ALL /MODEL=ALPHA.
Resources	Processor Time	00:00:00,02
	Elapsed Time	00:00:00,02

[DataSet1] \\PLAN.AAU.DK\Users\borhan\Documents\SPSS n Nvivo\pilot study.sav

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	7	100,0
	Excluded[a]	0	,0
	Total	7	100,0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
,840	29

Appendix H: Questionnaire on PBL learning environment

Part 1: Background Information

a. Gender ( )Male ( )Female

b. Age _____year-old

c. Years of teaching experience _____years

Part 2: Course Evaluation

For each item, please circle your responds according to the scale
(1=Strongly Disagreed, 2=Disagreed, 3=Agreed and 4=Strongly Agreed).

No	**Item**	**Scale**			
		SD	**D**	**A**	**SA**
	i. General impression				
a.	In general, I´ve worked enthusiastically during this course	1	2	3	4
b.	I spent a lot of time studying for this course	1	2	3	4
c.	The subject matter in this course was valuable for my study	1	2	3	4
d.	The subject matter for this course was difficult to understand	1	2	3	4
e.	I have learned a lot during this course	1	2	3	4
f.	I found the subject matter in this course interesting	1	2	3	4
	ii. Group learning process				
a.	I found it is a pleasure to work in my current group	1	2	3	4

b.	I feel comfortable asking for help from others in my group	1	2	3	4
c.	I feel that my group members listen to me when I present information	1	2	3	4
d.	I feel that my group members show respect for me and my learning style	1	2	3	4
e.	I feel comfortable sharing information with others	1	2	3	4
f.	Evaluating the individual efforts of myself and my group members helped our group function well	1	2	3	4
g.	As a result of this class, my ability to find, read and analyze information has improved	1	2	3	4
	iii. The PBL Task				
a.	The tasks were clearly stated	1	2	3	4
b.	The task prescribed too much what ones was expected to do	1	2	3	4
c.	The task provides sufficient stimulus to group discussion	1	2	3	4
d.	The tasks provided sufficient cues to formulate learning issues	1	2	3	4
e.	The task stimulate self-study sufficiently	1	2	3	4
	iv. The Facilitator				
a.	The facilitators appeared to be aware of the principles of problem based learning (PBL)	1	2	3	4
b.	The facilitators encourage all students to participate in group discussions	1	2	3	4
c.	The facilitators help me develop my reasoning process by posing questions, and challenging and critiquing information presented	1	2	3	4
d.	The facilitators guide and intervenes when necessary to keep group on track	1	2	3	4
e.	The facilitators encourage the use of a variety of resources	1	2	3	4

f.	The facilitators listen and responds well to student concerns and problems	1	2	3	4
g.	The facilitator appeared to be enthusiastic about guiding my group.	1	2	3	4
	v. PBL Benefits and Perspectives				
a.	Process of solving a problem is more beneficial than finding a solution	1	2	3	4
b.	PBL environment promotes open discussions	1	2	3	4
c.	PBL environment promotes team work	1	2	3	4
d.	I´m interested in taking another PBL module in the next semester	1	2	3	4

Suggestions to improve PBL sessions

_____
_____
_____
_____
_____

Thank you for your co-operation! ;)

Appendix I: Article 1: ***Problem Based Learning (PBL) in Malaysian Higher Education Context: A Review of Research of Issues of Implementation and Learners´ Experience***

Problem Based Learning (PBL) in Malaysian Higher Education: A Review of Research on Learners´ Experience and Issues of Implementations

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Since its inception about 40 years ago in a medical educational program at McMasters University, problem based learning (PBL) has evolved in many institutions worldwide and extensively applied in myriad fields regardless of geographical boundaries. Over the last ten years, many Asian countries have implemented PBL inspired by the success of this approach in western countries, especially in medical schools. Following this trend, PBL has been adopted in Malaysia within a variety of fields in higher education such as engineering, ICT and multimedia, medical and dental education, physics, and teacher education. As PBL implementation involves significant change in class management and the role of students and teachers, it is pertinent to address the issues that arise during implementation, and any viable and feasible solutions. Since PBL is relatively new to the Malaysian educational landscape, it is also important to document the ways in which learners´ experience PBL in terms of their perception, motivation, awareness and opinions. Specifically, this paper aims to document learners` experience in PBL learning and to outline issues related to previous PBL implementation specific to Malaysian higher education settings. Methodology involved identification of journal articles and conference proceedings on the implementation of PBL in Malaysian higher education from bibliographic databases for education and social science research, in particular that focus on implementation issues and learners' experience in PBL. These resources were selected based on specific selection criteria outline at the outset of the study. The study found that Malaysian undergraduate students experiencing PBL in their learning are positive, based on their perceptions, attitudes, opinions and motivation. Scaffolding students, staff training, and a supportive administration are among general issues in PBL implementation recurring in given disciplines. The paper concludes that Malaysian undergraduate students have largely positive perceptions and opinions of, and motivation towards PBL. Strong support from staff and faculty, and students and teachers' readiness appear to be the key ingredients for successful implementation of PBL in Malaysia.

Keywords: Problem based learning; higher education; implementation; learners' experience.

Introduction

There is a worldwide concern for the quest of excellence in teaching and learning in higher education and also a requirement for universities and higher education institutions to produce graduates who not only possess knowledge but also skills and competence to

apply that knowledge. Therefore, it is argued, there is need for pedagogical change in both undergraduate and graduate programs. A widespread worrying aspect has been that current curricula and pedagogy often fail to prepare students for solving authentic problems encountered in workplace or everyday life. In addition, students need to be equipped with higher order thinking skills and learning abilities as demanded by today`s marketplace.

Accordingly, Problem Based Learning (PBL) is seen as an appropriate pedagogical innovation for providing graduates not only with content knowledge, but also necessary skills and competences needed in their future professions. PBL is a curriculum development and innovative teaching approach that simultaneously develops both problem solving strategies and disciplinary knowledge bases by placing learners in an active role of problem solvers confronted with problems that mirror real-world situations (Finkle and Torp, 1995). Casey and Hawson (1993) likewise contend that the focus of cognitive approaches to education should be on the quality of thinking processes, rather than the accuracy of the answers they produce. Shifts in teaching and learning approaches in higher education based on cognitive and generic skills (Murray-Harvey and Slee, 2005) have contributed substantially to the development of the PBL curriculum in higher education.

Student-centred learning and collaborative learning are among the basic characteristics of PBL. Student-centred learning assumes the idea that student can "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). Teamwork among students engaged in collaborative learning increases the chances of success and enables the development of communication and interpersonal relationship skills. PBL aligns with the social constructivism theory that emphasize on learning and how to think and understand about a phenomena by interacting with peers in groups. 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. Constructivist promotes communication and social skills within a classroom environment that utilises collaboration and exchange of the ideas with others. This will lead students to evaluate their contributions in a socially acceptable manner. 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.

Review of PBL in Higher Education

Since its inception about 40 years ago in a medical educational program at McMasters University, PBL has evolved in many institutions worldwide and has been extensively applied in myriad fields in higher education such as medicine, engineering, science and economics (van Barneveld and Strobel, 2009) and architecture, law and social work (Bould and Feletti, 1991). Its flexibility and diversity make it possible to incorporate PBL in different ways, in variety of subjects, disciplines and in various contexts (Savin-Baden and Wilkie, 2001).

Most reviews to date however have focused on medical education (e.g. Albanese and Mitchell, 1993; Vernon and Blake, 1993; Norman and Schmidt, 2000; and Colliver, 2000) and measured the effectiveness of PBL over traditional or didactic methods. The conclusions from this work include that PBL is equal to traditional approaches concerning

knowledge acquisition, but that PBL students exhibit better clinical problem solving skills. One dissenting voice is that of Colliver (2000) who states that there is no convincing evidence that PBL improves knowledge and clinical performance. Dochy et al., (2003) analysed 43 empirical articles of PBL implementations across variety of fields in higher education and found a robust positive effect on students' skills albeit with a negative tendency concerning knowledge acquisition. Van den Bossche´s (2000) systematic review also yields a similar result pattern of PBL's positive effects on students' skills, but negative impact on their knowledge. From Asian continent, Khoo (2003) reviewed PBL practices in medical schools across Asia, concentrating on issues of implementation and students´ perception towards PBL. She concluded that most schools and students were positive about adapting to PBL, claiming that successful PBL implementation is enhanced by strong support from academic administrators and the training of both faculty and students. Another Asian-focused review paper is by Caesario's (2010). The review paper focuses on learning outcome, and responses and adaptability of Asian medical students towards PBL. Caesario (2010) outlines six issues in PBL implementation; passivity and low participation in discussion, preference for clear instruction over independent learning, tendency to be active in discussion, perception that PBL is time-consuming; poorly-structured problems, and that the environment is not conducive to small group discussion.

PBL in Malaysian Higher Education

In recent years, PBL has become one of the promising innovations in Malaysian higher education teaching and learning settings and has gained considerable prominence. 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). In the University of Malaya (UM), Said et al., (2005) pioneering the implementation of PBL at the Department of Chemical Engineering, inspired by the need for electrical engineering graduates equipped with analytical skills, critical and lateral thinking, technical skills, team work and time management. Favourable outcomes from this pilot implementation encouraged other faculties to initiate PBL in their own courses. For examples, PBL was incorporated in the Faculty of Education to accomplish the goals of preparing future teachers with new competencies and skills. In the University of Science Malaysia (USM), PBL in operation in its medical school. Throughout the 5-year program for both medical and dental surgery degrees, the curriculum is problem-based and community oriented. PBL sessions here are combined with lectures, practical, fixed learning modules and clinical clerkship. For example, a PBL session will last for 2-3 hours and consist of a group of 14-16 students with tutors who aim to facilitate students' learning (Barman et al., 2006). Overall then, PBL in Malaysian higher education is more integrated into engineering and medical schools, than in other subject areas. Since PBL is relatively new to Malaysian undergraduates, the initiators (Mohd-Yusof et al., 2005 and Said et al., 2005) proposed a hybrid PBL approach and a gradual PBL introduction throughout the academic years.

As far as can be determined, there has been no PBL review that specifically focuses on Malaysian higher education. In view of the gap in the empirical literature, the aim of this review is to address learners´ experience and general issues of PBL implementation in Malaysian higher education. Since the adoption of PBL require considerable changes from multiple perspectives, it is important to highlight what issues arise during PBL implementation from prior research. Thus, PBL implementation could be improve in the near future. The general aim for PBL adaptation in Malaysian higher education regardless of field is developing a more 'skilled' graduate. Hence, it is essential to address learners´ experience during PBL including their perception, motivation and awareness.

Methods

Search Strategy

The methods used for eliciting reviews on PBL included searching through several bibliographic databases for education and social science research (Educational Resources Information Center (ERIC), Web of Science (for Science Citation Index, Social Science Citation and Art and Humanities Citation Index), Scopus and PsycINFO) and searches of key research journals. Subject headings and keywords based on 'problem based learning' were combined with 'Malaysia' and 'higher education'. These produced a number of titles which were searched manually to trace potentially relevant papers, on the basis of abstract and descriptors. The selected publications were also used to assist in identifying other sources. Next, the snowball method was employed, i.e. reading selected publications which led to the identification of further relevant sources. Rickinson (2001) posits this method as a means to achieve comprehensiveness in a literature search, in which the search process is continuous until no new citations emerge.

Selection Criteria

The following criteria were defined at the outset of the study to select suitable articles for inclusion in the review; Focus on empirical studies of PBL intervention in Malaysian higher education context, focus on studies of undergraduate students in higher education context, the outcome measure of any study to be learners' experience of PBL in terms of perception, motivation, and awareness and identification of types of intervention or learning environment which fulfill the PBL characteristics cited by Barrows (2000), such as tutor/lecturer as facilitator of learning, learners` responsibility to be self-directed and self-regulated in their learning, the design of problems as the driving force for enquiry. With regards to the criteria, 15 articles were identified (from journals and conference´s proceedings) within various disciplines concerning medical science (Azila et al., 2001; Achike and Nain, 2005; and Barman et al., 2006), physics (Sulaiman, 2010 and Atan et al., 2005), engineering (Mohd-Yusof et al., 2004; Mohd-Yusof et al., 2011; Nopiah et al, 2009; Salleh et al., 2007 and Said et al., 2005), mathematics (Tarmizi and Bayat, 2010 and Sharifah and Lee, 2005), and multimedia and ICT (Neo and Neo, 2001; Sulaiman, 2004 and Yassin et al., 2010).

Result and Discussions

Learners' experience in learning through PBL

From the reviews, Malaysian undergraduate students from across disciplines reported good experience associated with learning through PBL. The favourable experiences could be linked from the skills and acquired knowledge and highly valued group collaboration and discussion in PBL. From medical fields, Barman et al., (2006) investigated how dental medical students perceived the PBL process in terms of interest, enthusiasm and personal satisfaction. The study showed that 70 percent of students wanted to retained PBL ways of learning for the subsequent semester, since PBL fosters their in-depth understanding, link basic science knowledge to clinical appraisal skills and develop group interaction skills. Azila et al., (2001) compared students' responses from PBL with ordinary subject-based tutorials. Students in PBL class agreed that discussion in PBL encouraged them to seek information and improved their understanding, integration and application of knowledge. Furthermore, they also felt that subject-based tutorials were much more efficient for obtaining information.

Physics and mathematics students valued their PBL experiences from knowledge, skills attitudes and motivations perspective. Atan et al., (2005) probed physics students' perception of learning through PBL and Content Based Learning (CBL) by means of formative and subjective questionnaires. Comparing the responses of students to both approaches, it was found that students of PBL outperformed their CBL peers in terms of achievement and exhibited more positive attitudes towards learning in PBL (acquisition in skills of meta-cognitive reasoning, and proficiency in problem solving). Tarmizi and Bayat (2010) employed quasi-experimental research as means to assess students' performances in statistics learning and motivation towards PBL learning at three different time intervals (after conventional learning, first-stage PBL and second-stage PBL). Motivation of students was measured by means of a questionnaire which comprises 36 items. The study showed a significant positive effect on students' motivation levels following PBL intervention. Sharifah and Lee (2005) research focused on students` activities and perceptions of PBL in a Mathematics Method course. The students agreed that the aspects of PBL that most contributed to their learning were discussion, group work, analysis and making sense of problems. They also enjoyed working cooperatively, improving their communication skills and adopting a more holistic outlook in their learning.

In engineering program, equipping engineering graduates with skills and enhance knowledge acquisitions are among the seminal aims of PBL implementation. Mohd-Yusof et al., (2004) introduced PBL in the 8^{th} to 11^{th} weeks of a chemical engineering course, aiming to enhance their generic skills. Data from student learning journals and questionnaires indicated that while there was a feeling of anxiety at the outset of the case study, chemical engineering students generally perceived PBL in a positive way, for example, in terms of the knowledge they gained, and their increased skills in problem solving, self-directed learning team-work and self-confidence. Salleh et al., (2007) adopted a PBL curriculum in an engineering course which aimed to address generic skills that correspond to those required of competent and marketable graduates. In the study, students´ perceptions were that they benefited in the content area, gained more of theory and practice, enjoyed the experience of working as team members and enhanced their study skills. Both facilitator and tutors felt happy due to students playing a more active

role during learning, which not only improved their mastery of content knowledge, but also inculcated generic skills. Similarly, Napiah et al., (2009) introduced PBL into a Statistical Engineering course to overcome lack of problem-solving and knowledge application in mathematics and basic statistics among engineering students. This study likewise showed students' positive attitude towards working in teams since for them, teamwork increases cooperation and trust between participants. They also agreed that PBL helped to develop their skills and confidence in group projects.

There are two research evidences explicitly describe student appreciation of group work in PBL. Neo and Neo (2001) assessed students´ perception of group project work and motivation in project development in a multimedia-supported PBL class. Findings from focus group interviews and supported by the mean score percentage indicated that at least two thirds (more than 70%) of students reported positive attitudes towards the PBL learning environment (e.g. highly motivated, enjoy being challenged, able to make creative input), an improved ability to think critically (PBL emphasis on thinking critically and enhanced understanding) and the ability to function well as team (e.g. learning more, developing common ideas, achievable goals). Sulaiman et al., (2004) incorporated PBL-ICT strategies into a traditional-based curriculum undergraduate course. The authors investigated students' perceptions of the effect of collaboration in PBL utilizing the Web learning environment of an undergraduate course. A special Web-based PBL learning context was developed and collaboration defined as student-instructor and student-student collaborative processes in terms of satisfaction and enjoyment. Analysis of findings revealed highly positive responses from students, in particular, their enjoyment of and satisfaction in the PBL process through engagement in the group task and scaffolding provided by the facilitator.

Issues in implementing PBL in Malaysian higher education

A number of issues have emerged concerning PBL implementation within a variety of fields in Malaysian higher education. Since conventional pedagogic and didactic methods are entrenched in Malaysian higher education, embarking on innovative and student-centred and active learning as devoted in PBL requires significant change, both physically and cognitively. For the purpose of the current review, the implementation issues are divided into two parts; before implementation and during implementation.

Before PBL implementation

Prior to PBL implementation, it is essential to obtain support from the administrators and prepare the academic staff for their new role in PBL class. Likewise, Achike and Nain (2005) identify two factors need to consider before embarking on PBL practices; open mindedness of faculty members in acceptance of PBL and academic staff training. Staff training is seen as particularly important since PBL requires a major change in teaching and learning processes, approach and principles. In a PBL class, a lecturer changes the role from knowledge provider to the facilitator. As a PBL facilitator, a lecturer should know how to motivate students in groups, when to intervene, how to encourage students to think critically and creatively, to which extend they should be given the information, and deal with the group dynamic and issues. Top-down support is also an essential factor for successful PBL implementation. Malaysian higher education system is highly

centralized, hence the supports, funding, and approvals come from the administrative people. Therefore, collaboration with the administrative division is very much necessary.

Preparing students with the necessary knowledge and skills to be successful in PBL is important, since present Malaysian undergraduate students have a minimum of 11 years of traditional schooling at primary and secondary levels. Salleh et al. (2007) argue that the Malaysian school system is exam-oriented and therefore less favourable to deep understanding and skills development as demanded in a PBL class.
Oldfield and MacAlpine (1995) commented "In a new situation, students must have concept introduced to them in absorbable and achievable steps, they must receive understandable feedback at each stage and their confidence must be build from experience". Likewise, Segers et al., (2003) and Thomas (2000) relate the effectiveness of PBL approach rely upon providing range of supports and scaffolding to help learners learn how to learn. Lack of experience of methods adopted in PBL such as cooperative group working, taking responsibility for one's own learning, searching for relevant information, communicating, etc. can increase stress and worry among students (Kelly and Finlayson, 2007).

From the review, there are two proposals on how to prepare Malaysian undergraduate students towards PBL; Give more motivation, encouragement and guidance for students not ´accustomed´ to PBL at the beginning of the semester (Mohd-Yusof et al., 2011) and introducing PBL gradually throughout the academic year and having fewer PBL-devised problems in the first year of a course (Said et al., 2005) so that students will gradually familiar with PBL learning. This is proven from Mohd-Yusof et al. (2004) research. Here, PBL evaluations indicated that the popularity of PBL increases with experience: from only 60% of the students preferring PBL over traditional methods after one semester, to 83% indicating a preference for PBL after the second semester. This suggests that the students are better able to cope with PBL demands, the more experience they have of it and from the lecture-based chemistry module that runs concurrently with the laboratory module. There is further evidence from this evaluation, that some students feel an initial sense of frustration when confronted with a new approach. Such frustration is less evident at the end of second semester.

During PBL implementation

PBL is all about group learning, in which students make sense of learning by interacting with the peers in the group. Several group issues were reported from the previous implementations. Azila et al., (2001) reported the difficulty students face in conducting PBL discussion in English, which is a second language for them. This of course, will affect learning since students are not able to express their thoughts thoroughly as in their first language. In Malaysian higher education institutions however, most science, medicine and engineering clusters use English language as the medium of instruction as this is a national strategy for internationalization and for exposing Malaysian graduates to the challenges of globalization. However, from the semi-structured focus group interview conducted by Sulaiman (2010) to elicit physics students' perceptions of learning through PBL, it was reported that some students see PBL as an opportunity to improve their English proficiency in communication and discussions.

Another recurring group issues reported from the previous PBL implementations in Malaysian higher education is passive participation in group discussions and free riders, students who draw largely on other people's work. A study by Yassin et al., (2010) of a PBL-ICT strategy for the interdisciplinary integration of educational courses of three cohorts of Post Graduate Diploma in Education found evidence of free riders. To counter this, while students were given a group assignment for Cycle 1, the same assignment was repeated as an individual exercise for Cycle 2, to ensure that each student take responsibility for their own learning. Passive participation in group discussions were largely contribute by the inexperience of group learning skills among the Malaysian students, since their schooling background is devoted to traditional learning. A PBL facilitator could not expect that the students will develop the group learning skills by their own. Edwards and Hammers (2004) address this issue by suggesting that scaffolding should be introduced so that learners develop skills associated with effective group collaboration. Studies suggest that PBL is more demanding of tutors since students expect more feedback and guidance from them. Furthermore, students expect facilitators to be subject specialists, be prepared before attending the sessions and be more interactive (Barman et al., 2006). To some extent, they also perceive the success of a PBL session to depend on facilitators' expertise. From the review, Mohd-Yusof et al., (2004) proposed a Cooperative Problem Based Learning (CPBL) framework to assist students to get the feedback and support from peers, rather than solely relying on the facilitators.

Conclusion

The paper aims to shed light on learners´ experience and issues related to PBL implementations. From the learners´ experience, regardless of the discipline boundaries, students in PBL class informed about the skills they archived in participating in PBL like the interaction, problem solving, self-confidence, self-directed, critical thinking, and team working. Apart from skills acquisitions, PBL also fosters their in depth understanding, enhanced their theoretical knowledge, and promote deep approach to learning. Group working in PBL is seen as the way for students to actively participate in learning process, hone their skills to seek for the information, hone their cooperation and trust among peers in the groups and inculcated their ability to function well as a team. Strong support from staff and faculty, and students and teachers' readiness appear to be the key ingredients for successful implementation of PBL in Malaysia.

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Appendix J: Article 2: *A Review of the Impact of Problem Based Learning (PBL) on Pre-Service Teachers' Learning*

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A review of the impact of PBL on pre-service teachers' learning

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Inspired by positive results of Problem Based Learning (PBL) implementation within an array of disciplines, PBL was also implemented in teacher education fields since 1980's. Since then, the literature of PBL implementation and its impact teacher education have been growing. However, there was no review work reported to conclude on how PBL impact specific learning outcomes in teacher education. Hence the aim of the paper was to review the research evidences concerning the impact of PBL implementation focusing on pre-service teachers´ knowledge and skills. Resources (journal articles and paper proceedings) were obtained from bibliographic databases and key research journals. The resources were chosen based on specific inclusion criteria, followed by a common review framework to ensure commonality and comprehensiveness during the review. The review works concluded that a PBL experience within teacher education provided opportunities for pre-service teachers to simultaneously acquire knowledge and to develop skills deemed important for the future teachers. This information is important to further refine PBL employment especially in teacher education, and to contemplate rooms for improvement, which will subsequently lead to an improved constructivism learning experience for pre-service teachers.

Keywords: Problem based learning; pre-service teacher; teacher education; knowledge; skills.

Introduction

Call for the excellence in teaching and learning in higher education and university graduates with skills and competences is inevitable due to the results of globalization. Pedagogical practices in higher education are rapidly urged to reflect these calls. Lecture-based pedagogy, which dominantly represents pedagogical practices in higher education is no longer sufficient to prepare such traits of graduates. Being at the frontline in preparing school teachers, teacher educators must continually seek better ways to strengthen their students´ (pre-service and in-service school teachers) knowledge, skills and dispositions in order to be successful in diverse classrooms. Goh (2011) laid out some key challenges faced by teacher educators to keep abreast with the recent standards of teacher education. In recent years, Problem Based Learning (PBL), a teaching and learning approach has become one of the promising innovations in higher education. Defining PBL might be a challenge since researchers define it differently to reflect the aims and objectives, context of the implementation, learning principles or PBL models. In their seminal work on PBL, de Graaff and Kolmos (2003, 2007) define PBL based on their analysis of the learning principles and across variety of PBL models. PBL definition provided by de Graaff and Kolmos (2003, 2007) can be divided into three approaches:

i. The **cognitive learning approach** means that *learning is organized around problem* and will be *carried out in projects*. The problem is the starting point of the learning process, place students to learn in context, and learning is based on students´ learning experiences.

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ii. The **contents approach** concerns with *interdisciplinary learning* that involved divergent of the subject related boundaries and methods. The contents approach also emphasize on linking the theory and practice
iii. The **collaborative or social approach** involves *team-based learning* whereby learning occur through dialogue and communication between group members. Students learn from each other by sharing the knowledge and organizing the group learning process.

Since its inception about 40 years ago in a medical educational program at McMasters University (Barrows, 1996), PBL has evolved in many institutions worldwide and extensively applied in myriad fields such a architecture, law and social work (Bould and Feletti, 1991) and professional education such as nursing, design, engineering, optometry, architecture, law and business (Chappel and Hager, 1995). The flexibility and diversity of PBL make it possible to be incorporated in different ways, in variety of subjects and disciplines and in various contexts (Savin-Baden, 2001). Biggs (1999) viewed PBL as a promising strategy to align university courses with the real life professional works students are expected to undertake after graduations. Given the perceived advantages of PBL in other fields, there would appear to be a good case for the introduction of this teaching and learning approach within teacher education. In fact, PBL approach has become the centre stage in teacher education since 1980s (Merseth, 1996).

PBL implementation in teacher education

In teacher education fields, PBL has been implemented in both graduate and undergraduate level and in variety of courses like Foundations of Education, Inclusion Classrooms, Elementary School Curriculum, Introductory Educational Psychology, Educational Research and Methods (Levin, 2001), and Science Education (Watters, 2007, Goodnough, 2003 and Peterson and Treagust, 2001). The drivers for PBL implementation in teacher education are varied from one case and another, but mostly devoted to better prepare the pre-service teachers to be more relevant in their future teaching professions. Issues such as diversity of students´ background, inclusive classrooms and ongoing development of technologies (Dean, 1998 and Goodnough, 2006) has changed teacher´s role in schools from merely imparting the knowledge to the one that inculcate creativity, intellectuality, problem solving ability and critical thinking skills among students. Beginning teachers need to be equip themselves with necessary skills, attitudes and disposition to correspond with the ever-changing and complexity of the school classrooms. A study by Lim et al. (2012) indicated that a major challenge to change student approach to learning is to change teachers´ perception of learning conception. In response to this call, PBL is seen as a platform to enhance pre-service teachers´ acquisition of knowledge and skills, and to prepare them for varied roles of a teacher through PBL learning process that involves authentic PBL scenarios, group collaborations, authentic assessment and self-directed learning. Finkle and Torp (1995) described PBL as a curriculum development and instructional system that simultaneously develop both pre-service teachers´ problem solving strategies and skills by placing them in the active role of problem solvers confronted with an "ill-structured" problems that reflect real world problems. In similar arguments, De Simone (2008) suggests that a PBL problem scenario drawn from real-life problems could enhance pre-service teachers ability to define the problems, generate solutions, and application of practical and literature-based resources in search for problem`s solution. Research results from Watters (2007) concluded that PBL was effective in helping pre-service teachers to adopt a deep approach to learning and enhanced confidence to teach science in schools.

As a relatively new teaching and learning approach in teacher education, researchers of PBL in teacher education provides arguments on compatibility of PBL and teacher education. For example, McPhee (2002) suggests the teacher education itself should be seen in the frame of constructivism and devoted, but not limited to, child-centered perspective. A PBL problem scenario of *"an excel, highly motivated secondary school students with the sudden drop off of achievement, and change in behavior"* will serve the opportunity for pre-service teachers to explore interrelated issues like motivation, learning theories, learning behavior, and national standard and policy. Therefore, from a specific problem scenario, pre-service teachers will have the opportunity to experience interdisciplinary learning, which represent the central principles of PBL. Peterson and Treagust (2001) posit that the knowledge (content knowledge, curriculum and learners) integration and call to have lifelong learners in teacher education serves teacher education as appropriate for a PBL implementation. Levin (2001) provides an argument for the relevant of PBL application in teacher education course. The important to redesign an undergraduate teacher education course is to make learning more relevant and engaging, to help pre-service teachers perceived their profession as a true profession worthy of their intelligent and passion. Likewise, Dean (1999) seen PBL as an important vehicle to expose the pre-service teachers to the situation that they are likely to face as professional educators whilst simultaneously practicing a teaching and learning approach that encapsulates the central tenet of constructivism and social constructivism learning theory.

Review works of PBL implementations and its effects

Most of the review works to date are devoted for medical education (e.g. Albanese and Mitchell, 1993; Vernon and Blake, 1993; Norman and Schmidt, 2000; and Colliver, 2000) measuring the effectiveness of PBL approach over traditional or didactic methods. In general, these works concluded that PBL students perform better on clinical knowledge acquisition and skills, while their peers in conventional curriculum perform better on basic science knowledge acquisitions. Dochy's et al., (2003) meta-analysis and systematic review by van den Bossche et. al., (2000) on the effects of PBL concentrating on knowledge and skills across variety of fields further verified the above findings. Dochy et al., (2003) analyse 43 empirical studies on PBL in higher education articles and finding suggests a robust positive effects on students' skills albeit there is a tendency to negative effects when looking on the effect of PBL on the knowledge. van den Bossche´s et. al., (2000) systematic reviews yielded similar result pattern to affirmed PBL has positive effects on students' skills but negative effect on their knowledge. However, a literature review conducted by Colliver (2000) suggest a contradict results. The author found there was no substantial evidence that PBL improve neither knowledge nor clinical performance of students.

As far as can be determined, there are no review reports on the implementation of PBL in teacher education despite the growing number of PBL in teacher education literature. Reflecting on the cumulative empirical evidence on how PBL impact pre-service teachers´ knowledge and skills holds the potential to refine its employment, and contemplating any rooms of improvement, which will subsequently leading to an improved constructivism learning experience for pre-service teachers. In addition, this review works will contribute to the knowledge gap of the scarcity of PBL implementation in teacher education programme (Kwan, 2008 and Chappel and Hager, 1995). Therefore this article reports the findings from a review work of research evidence of PBL implementation in teacher education focusing on the knowledge and skills acquisitions of pre-service teachers.

Methods and procedures of review process

To begin the review process, the previous empirical research articles that serve as the data sources for the review purposes were search thoroughly to obtain most of the relevant empirical research articles, if it is not all. These empirical research articles were retrieved from several bibliographic databases for education and social science research such as Educational Resources Information Center (ERIC), British Educational Index, Web of Science (for Science Citation Index, Social Science Citation and Art and Humanities Citation Index), PsycINFO, key research journals (e.g. European Journal of Teacher Education and Asia Pacific Journal of Teacher Education) and searches in System for Information on Grey Literature in Europe (SIGLE) for grey literatures. Subject headings and keywords based on "problem based learning" were combined with "teacher education" and "pre-service teachers" produced number of titles. The periodic indices and content table of issues were search manually by reading the abstracts. To ensure a thorough and standard selection of articles, the study established a specific selection criterion to choose suitable articles for inclusion in the review process. The articles should present the empirical data of the PBL implementation in teacher education domain that may include educational research methodology, psychology in education, pedagogy, philosophy in education, teaching and learning approach in school and sociology in education. The next criterion is on the research variable measured. The variable should report on the impact of PBL on pre-service teachers´ knowledge and skills, regardless whether these are the main or complimentary variable measured in that study. Since PBL can be define from variety of perspectives, it is also essential to choose a specific PBL definition yet broad enough to represent the central concepts of PBL. Therefore, the study chooses widely-accepted de Graff and Kolmos (2003, 2007) definition of PBL. Table 1 summarizes the specific criteria for choosing the articles for review purposes:

Table 1. Four criteria to select articles for review process

Criteria		Description
v.	Type of studies:	Original and empirical studies with primary data
vi.	Focus:	Employment of PBL intervention in teacher education context
vii.	Scope of variable:	Mainly report on the participation of knowledge and skills of pre-service teachers after engaging learning through PBL
viii.	PBL characteristics:	Identification of types of intervention or learning environment which fulfill the PBL learning principles define by de Graaff and Kolmos

(2003, 2007):

j. The **cognitive learning approach** means that *learning is organized around problem* and will be *carried out in projects*. The problem is the starting point of the learning process, place students to learn in context, and learning is based on students´ learning experiences.

ii. The **contents approach** concerns with *interdisciplinary learning* that involved divergent of the subject related boundaries and methods. The contents approach also emphasize on linking the theory and practice

iii. The **collaborative or social approach** involves *team-based learning* whereby learning occur through dialogue and communication between group members. Students learn from each other by sharing the knowledge and organizing the group learning process.

Upon completing the selection process, the snowball method was employed whereby the selected articles were fully read to identify of further relevant sources either in the content/ text or in bibliographic section of the articles. Rickinson (2001) posits this methods as a means to achieve comprehensiveness in a literature search, in which the search process is continuous until no new citations emerge. Following the selection criteria, each individual article underwent reviewing process to determine the impact of PBL on pre-service teachers´ knowledge and skills. To ensure commonality and comprehensiveness of review process, a review framework were established as depicted in Table 2:

Table 2. The review framework for selected articles

Component		Description
viii.	Research aims	A summary of the aims of the research study as reported by the researcher in their article
ix.	Theoretical/conceptual approach	Summary of the key theoretical/conceptual assumptions that underpin the work reported (but only in so far as these are explicated and acknowledged by the authors)
x.	Methodology	The broader epistemological and theoretical framework that surround and underpin the method of the study (only in so far as these are explicated and knowledge)
xi.	Validity measures	A value aim at measuring validity or reliability (howsoever conceived) that are reported by the author (s)
xii.	Methods	Summarized detailed of the reported procedures of data collection and data analysis
xiii.	Main findings	Summary of the study´s main findings as reported by the author
xiv.	Key conclusions	Summary of the main conclusions drawn from the study´s findings by the author(s)

(derived after Rickinson (2003), pg.271)

The review process begins by reading briefly the selected articles based on the components as listed on the above table. *Research aims* of an article are a general description of what to achieve in the research. As for *theoretical/conceptual approach*, the key assumption of theory application or theory generation is the one that underpin PBL which including constructivism, active learning and social constructivism. To achieve what is claimed in the articles, the *methodology* should sufficiently explained the alignment between research approach, data collection and data analysis. To measure pre-service teachers´ knowledge and skills, the instrument or tool that used to collect the data should also discuss on the *validity measure* that may include Cronbach alpha for qualitative measure or validity value for quantitative measure. Entailing the validity measure description is *methods* whereby author explains on the procedure in collecting the data and the analysis approach that aligned with the aims of the research. Next is the *main findings* that reported on how the PBL implementation impact pre-service teachers´ knowledge and skills. Some articles might have other findings which are also helpful to understand more on the impact. Last component to review is the *key conclusions* that drawn from main findings that may also include implications and suggestions.

Results and discussions

Skills

It is widely enunciate that PBL fosters skills acquisition, development and improvement among the learners. As in teacher education field, the call for the pre-service teachers to develop and equip with critical and analytical abilities to deal with the complexities and diversities of their classroom is inevitable. Consonant to this calls, PBL is seen as a vehicle for skills inculcation since its emphasize active learning experiences that pre-service teachers engaged during their teaching preparation course. The first research evidence of skills acquisitions was from Edwards and Hammer (2004) in their research on pre-service teachers and change towards PBL. The authors concluded that the PBL approach is particularly suited for teacher education as it offers them the opportunity to acquire skills and theoretical content relevant to their future careers. Furthermore, pre-service teachers also associated the benefit of participating in a PBL scenario that deals with the realistic nature of the experience and saw the opportunity to develop skills considered to be necessary to them as future teachers.

De Simone (2008) measured pre-service teacher`s problem solving skills between experimental class (PBL approach) and control group (traditional approach). The author found out that experimental group exhibit better skills in constructing the central problem, elaborate the problem, connection between solution and problem and used of multiple resources. Similarly, Senocak et al., (2007) employed a quasi-experimental research design to compare pre-service science teachers´ achievement. Pre-service teachers were invited to evaluate their PBL learning experience on four different scales. The results indicated that PBL help them in developing variety of skills such as critical thinking, literature searching, self-directed learning and problem solving. These findings are supported by Taplin and Chan´s (2001) research outcome. The authors observed the development of skills and understanding of pre-service teachers as problem solvers. The use of journal entries and evaluation forms to probe pre-service teachers´ self-reflection as problem solvers and possible change in their thinking about teaching yielded mixed results. Although the pre-service teachers do not favour to tackle the pedagogical problems and reluctant to make their own decision to solve the problems presented, they showed ability to develop appropriate problem solving strategies skills and understanding in short time.

Murray-Harvey and Slee (2000) applied PBL in attempts to help pre-service teachers make connection and applying their online learning to life. To measure the impact of PBL, the authors used their feedback and peer reflection as the data resources. Evaluation of pre-service teachers´ responses showed their agreement that PBL process help developed their critical skills, reflective skills and skills needed by teaching professions. McPhee (2002) used pre-service teachers´ learning feedback and questionnaires to investigate their learning experience in issues-based learning in the classes. Pre-service teachers described the benefits of PBL as a ways to improve their skills in communication, team working and retrieving relevant information. Murray-Harvey et al., (2004) evaluate pre-service teachers´ assessment of their learning in PBL environment across four area of skills development: group processes, problem solving, knowledge building, and interpersonal skills through a self-rating questionnaire. To determine any growth of these competences between two case studies, the authors run a statistical test and found out that on all competences, pre-service teachers had a significant increment in their performances and skills across two case studies.

Knowledge

In documenting the research evidence of the impact of PBL on pre-service teachers´ knowledge, there are two categories of knowledge reported: Pedagogical Content Knowledge (PCK) and conceptual content knowledge. PCK is a notion coined by Shulman (1986) and is define as *"the most powerful analogies, illustrations, examples, explanations and demonstrations- in a word the ways of representing and formulating the subject, that make it comprehensible for others".* Despite criticism that PBL emphasize in higher order thinking and problem solving skills at the expense of low level knowledge acquisitions, there are some empirical research evidences to suggest PBL is also promote knowledge acquisitions.

Inspired by the limitation of science knowledge among pre-service teachers, Peterson and Treagust (1998) developed a PBL learning framework that address pre-service teachers´ knowledge base for teaching (science content knowledge, curriculum knowledge and knowledge of the learner) and pedagogical reasoning ability (comprehension, transformation, instruction, evaluation, reflection and new comprehension). Using case studies as way to elicit the impact of PBL, pre-service teachers have been reported to develop their knowledge base and pedagogical reasoning that correspond to their current belief in primary teaching and school student learning. So and Kim (2009) integrate PBL in information and communication technology (ICT) with the aim of better preparing future teachers of having pedagogically sound technology integration, or technological pedagogical content knowledge (TPCK). From the surveys and the lesson design artefacts, pre-service teachers has had understandings of pedagogical knowledge about PBL, despite reporting of having difficulty to crafting authentic and ill-structured problems and designing tasks with a balance between teacher guidance and student independence.

The concept of conceptual knowledge is defined as the amount and organization of subject matter knowledge held in the mind (Shulman, 1986). Askell-William et al., (2005) investigated pre-service teachers´ written reflection to elicit the changes in their mental model of teaching and learning following the experience of a PBL activity. Categories derived from pre-service teachers´ manuscript indicated that PBL process especially related to the case study expand their knowledge about factors influence child development. Kwan (2008) gauge learning experiences of pre-service teachers towards 3 modes of PBL delivery, namely Mode 1: The classical PBL, Mode 2: The Alternate PBL and Mode 3: The Modified Model. The findings revealed that both Mode 1 and Mode 3 were deemed feasible by pre-service teachers in constructing their knowledge because its require substantial mental processes that lead to meaningful discussion (Mode 1), and they are able to cover broader perspective of factual knowledge within limited class time (Mode 3). In preparing future teachers for teaching with technology, Albion and Gibson (2000) combine an interactive multimedia (IMM) packages based on PBL principles to help pre-service teachers integrate technology in their teaching and learning sessions. Their evaluation of the approach elicited from a survey revealed that pre-service teachers gained insights and knowledge in technology, self- organization and classroom management.

Conclusions

Across an array of university courses and programme, PBL implementation in higher education is strive to forge the innovative pedagogical approach with the real world of professionals. In the current study, the general aim of PBL implementation in teacher education is to better prepare them with variety of school and classroom issues such as change in educational policy, use of technology in classroom, and diversity of the school students. The central tenets of PBL that highly emphasize the disciplinary knowledge integration and development of higher order thinking skills accelerate the merge between the desire to initiate new pedagogical practice in teacher education at one hand, and to equip pre-service teachers with knowledge, skills and dispositions on another. School-based assessment, inclusion of generic skills in school curriculum and shift toward outcome-based education are among the seminal issues that create a call to prepare teachers that both knowledgeable and skilful. From the collective empirical evidences of PBL impact of implementation on pre-service teachers´ skill and knowledge acquisitions, it is clear that PBL enhance their knowledge and skills. Current review works have shown that PBL appears to be appropriate in inculcating skills demanded in teaching profession such as information processing-related skills, critical thinking skills, self-directed learning skills, problem solving skills and social skills. Though PBL emphasize more on skills acquisition over knowledge, knowledge acquisition is seen as equally important as skills for the pre-service teachers. The review work also revealed that PBL address both pre-service teachers PCK and conceptual knowledge. Both type of knowledge are particularly important to acquire by pre-service teachers for them to be relevant in teaching professions. As Peterson and Treagust (1998) suggest, PBL in teacher education could converge in addressing the development of content knowledge and PCK, and the central characteristics of PBL problems could lead to the development of range of knowledge from curriculum

knowledge to how children learn. These findings indicated that PBL is one of the most feasible teaching and learning approach in preparing our teachers for today´s schools. It is concluded that a PBL experience within teacher education facilitates pre-service teachers learning not only on the content level, but also on the methodological and behavioural level by providing skills to formulate and action teaching and skills. These skills will be required of school teachers when they are to be abreast with variety of school issues. Therefore, in effort to engage and retain the teachers for schools, improving teaching and learning strategy should be improved to strengthen their knowledge, skills and disposition and from this review work, PBL is one of the answers.

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Appendix K: Article 3: ***Problem Based Learning (PBL): A Context for Collaborative Learning Process at Aalborg University, Denmark***

Problem Based Learning (PBL): A Context for Collaborative Learning at Aalborg University, Denmark.

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This study involving six first year´s Medialogy undergraduate students seeks to provide insights into students perspectives of learning in a collaborative group context, learning impact and reflection associated with the participations in a Problem Based Learning (PBL) learning environment. The first semester of the undergraduate studies in Aalborg University is devoted to prepare students to acquaint with PBL learning environment, especially in working collaboratively on a group project. After collecting data through interviews (at the begging and the end of the semester) and process analysis report, the interview audio were fully transcribed to identify emerging themes and the group process analysis reports were analyzed using content analysis techniques. The results indicated that group learning process started with brainstorming ideas the tasks is divided based on both voting strategy and group member´s capability strategy. Reflecting on their learning process, students identified aspects that they need to improve including planning the timetable, enhance rapport among group members and emphasize on the quality of the discussions. In terms of the impact of PBL on student learning, students realized that they obtained skills, developed habits of peer learning and more organized learning.

Keywords:

Problem based learning; Aalborg PBL Model; group learning strategies; students´ reflection; impact of PBL learning

1. INTRODUCTION

Since 1974 Aalborg University (AAU) has utilizes the Aalborg PBL which is an innovative teaching and learning model that integrate PBL into project-based learning, with a substantial focus on project activities throughout the curriculum (Kolmos, 1996). In this model, group of students work on a project in each semester, and the number of

members in the group will be reduced towards the end of the programme. The AAU´s Faculties of Engineering and Science adopted six central principles of the problem and project based approach to guide the development of study programme; problem orientation, project organization, integration of theory and practice, participant direction, team-based approach and collaboration and feedback (Barge, 2010). Since AAU adopted the PBL approach at the systemic level, it is essential to prepare students to get acquainted to the PBL ways of teaching and learning. Therefore, the outcome for the first year studies focused on the ability of a student to grasp methodology for structuring the projects and process competencies. A course called *Pv: Introduction to PBL and the course* serve the purpose to achieve this learning outcome. The course provides both theoretical and practical support for students to deal with the project planning, collaborative learning, problem analysis, conflict handling, writing and structuring reports, and supervision. Generally, the course provides support for student collaborative learning and the ways to planning and conducting a specific, group based, problem based projects (Mosgaard and Spliid, 2011). Typically, a group consisted of 6-7 students in the first year and each group is allocated a group room. Within a given thematic problems with fixed learning goals, students in group develop their own projects supervise by a facilitator. The group and the facilitator will agree on the frequency of meetings, virtual communication such as email or *Skype*, and mutual expectations between both parties. The project is assessed through individual oral examination to determine whether the learning goals have been achieved.

The increment of student mobility within European countries has increased the number of international student enrollment in AAU. Despite the facts that student-centred and innovative pedagogies are gradually adapted in higher education institutions worldwide, the PBL model as practiced in AAU has different features since its emphasize on project work, process competencies development and collaborative learning. Therefore with no exceptions, these international students are required to enroll in the Pv course to help them familiarize with the new learning systems. As a relatively new and innovative pedagogy, introducing PBL to international students who accustomed to conventional ways of learning might create tensions among them to work with others, to manage the information from group members and to handle the group projects. This may be linked to different expectations and prior knowledge that students bring with them to the programme. Entailing these issues, the purpose of the paper is to document first-year student learning experience in relation to the AAU PBL learning environment. In particular, the paper aims to address the following inquiries:

i. What are the students´ group learning strategies in PBL?
ii. What are the students´ reflection and impact of learning in PBL?

Several previous studies on student learning in PBL argue the important to include student perspectives and learning process in the effort improve the PBL practice in higher education. Faidley et al., (2000) and Holen (2000) were in agreement of the importance to understand the group work process since the benefit of PBL is more likely achieved by students through working together rather than individually. Loyens et al., (2006) suggest that in understanding the processes and outcomes of PBL, students´ conceptions of what is means to engage in constructivist learning activities need to be taken into considerations. Likewise, Ellis et al., (2008) emphasized not to assumed students as oblivious participants in blind trials since their creativity and constructive views on their learning process is essential to higher education. The collective descriptions of students´

experience provide insight into their needs, expectations, difficulties and challenges. Consequently, it shed light on the nature of organization and delivery of PBL, which in turn will help improve the design of PBL curriculum. Furthermore, reflecting on the ways student learn in group and issues they encounter add to the current discourse relating to PBL in higher education and holds the potential to improve educational experience to the learners in general.

2. METHODOLOGY

2.1 Research Design

Research design is a plan or framework for a study used as a guide from broad assumption to detailed methods of data collection and analysis. According to Creswell (2008), selection of a research design is based on the nature of the research problem or issues under scrutiny, researchers´ experience and the audiences of the studies. The current research adopted exploratory research design to address the research inquiry. Exploratory research design is deemed appropriate to gain insights, ideas and better understanding of student learning in a PBL environment.

2.2 Participants

Six undergraduate Medialogy students were involved in the study and their participation is voluntary, in which the author went to their group rooms and asked for their willingness to participate in the study. All students are in their first semester, a semester devoted to prepare AAU undergraduate to learn in PBL environment. Two students were Danish and they are familiar with group learning since their college and high school education emphasize on group working and collaborative learning. Another four students are international (two Lithuanian, one Turkish and one Korean) in which they had never experience group learning or PBL in their previous education. Of six students, one is female and international.

2.3 Data Collection and Procedures

Semi-structured and open-ended interviews are conducted to obtain data on students learning. This type of interview is deemed appropriate data collection technique to obtain an in-depth perspective of students´ perspective on their learning. The interview are administered twice for each students; at the beginning of the semester (week 3) and at the end of the semester after students submitted their group projects and waiting for their group examination (week 15). Since this is an explorative studies, the insights obtained during the first interview sessions is used to develop interview protocol for the second interview sessions. The interview session started with the explanation of the interview´s purpose, confidentiality, anonymity, and obtained their permissions to audiotaped the whole interview sessions. The interviews explored students background, previous experience of group work, the PBL learning process including, problem solving process, facilitation process and challenges. The interview was loosely structured to give opportunity to students to form the interview from their own views and experiences (Seidman, 1998) and to minimize interviewer´s influence in their responses. Depending on the willingness of the students to share and talk, each interview sessions lasted from 20 minutes to as much as 70 minutes. To complement the inquiry on group learning process, the group process analysis reports are also obtained from the students. Group process

analysis report is a description of assessment and analysis of student group work within a problem-oriented and project-organized group whereby students in group write about the project management, group collaboration and collaboration with supervisors.

2.4 Data Analysis

The interview audio are fully transcribed using *NVivo9* software and each interview transcript received a unique record number for referring purposes. Interview transcript are then analysed using inductive analytical approach (Thomas, 2006) approaches, in which transcripts are read repeatedly, counting instances of common important issues to derive theme, concepts or model across the transcripts (Riley, 1996). The list of categories lead to the emergence of themes after refining it by read comparatively against each transcript to seek for commonality and contradictions. For the group process analysis report, document analysis techniques were used to analyzed the data.

3. RESULTS AND DISCUSSION

First part of results and discussion consist of collaborative group learning process that reports on group strategy to initiate the discussions in the group, the way they divide the tasks upon completing the discussions and how the groups use the project management tools. Second part reports on the students' reflection on the group learning process. Last parts of the results and discussion report on the impact of PBL on student learning. The results were presented and discussed through the use of direct excerpt from the interviews and compared with related previous research from the literatures. The interview excerpts were coded as IV_#. The asterisk symbol represents the unique number of the interviewees.

3.1 Group Learning Strategy

As a learning approach that emphasizes group work, discussions among the group members is essential in a PBL learning environment. Be it structured or unstructured, discussion is an important element for negotiating the knowledge and decision making use by students within Aalborg Model. Across all the six interview sessions, students were using the same strategy to start the group discussions, which is by brainstorming the ideas. The purpose of the brainstorming is to get the most feasible ideas from the group members to proceed with the projects. This is prevalent from the following excerpt:

> "Start with the brainstorming the ideas and will pick the best ideas and best methods to proceed with the projects." (IV_1)

> "The discussion start by extracting the ideas from each group members, and the group will select the idea which is the most feasible." (IV_4)

"Best ideas" or "feasible ideas" might be the one that represent the general ideas dealing with the projects. Since this is initial discussions, the ideas should be broad yet able to guide the group all the way through the end of the semester. Upon determining which ideas that they would like to proceeds, the ideas that could take in variety of form such as suggestions and opinions underwent series of processes and in-depth discussions to specify it according to the project aims and visions. These mutually accepted ideas underwent integration with other complement ideas to improve it. In this stage, students engage in questioning to obtain additional information, hypothesize about underlying

causal explanations link with their prior knowledge and perform research that might help to clarify it. Therefore, for some groups, the brainstorming sessions could take for two or three days for the group to expand and discuss the ideas more thoroughly from different perspectives. As AAU implements PBL in systemic level, the concern is not only to provide group room for students, but also facilities in the group rooms to help utilize student discussions. Two students mentioned that they groups were using the facilities in their group room to help them in their brainstorming sessions:

> "Use of whiteboard to manage the information during the discussions." (IV_2)

> "Start the brainstorming session with the drawing of the mind maps on the blackboards to get members´ opinion and point of view." (IV_5)

From the excerpts, the boards are used as a medium to convey and share information with the group members. The movable chairs and tables in the group rooms are also convenience for different setting of discussions. For example, students will merge together their tables for group discussions, or arrange them in a line for individual presentations. These facilities are important to help structure and guide the group learning process (Dillenbourg, 2002).

Mutual learning is a key feature of PBL whereby student in group share the workloads and knowledge is develop from group learning. Hmelo-Silver and Eberbach (2012) posited that group in PBL helps to distribute the cognitive load among group members by taking advantages of group members expertise to deal with the problems that normally difficult for individual learning. From the interview findings, there were two strategies in dividing the tasks and sharing the workload among the group members; based on group members capability and based on voting. In dividing the tasks based on group member capability, the group assigned the tasks to group members that are most knowledgeable among them in particular tasks. Two students (IV_1 and IV_4) remarked that their groups divided the tasks based on *"group members´ capability of doing specific tasks"* and *"the strength and weaknesses of the group members".* A student further explained on how his group is divided the tasks based on group member capability:

> "We had a group member that are well-verse in sounds for computer program like creating, adding and mixing the sounds. So he always take up the tasks that related to sound." (IV_2)

Across the interviews, students justified that by giving the tasks to those who are already familiar with it, that person will take less time to complete the tasks and possibly would do it better than the rest. Another reasons concern with the limitation of time. With other assignments deadline, students often found that it is helpful to complete their group projects within the deadline if the tasks are given to those who are knowledgeable in it. In contrast to the aforementioned ways of dividing the tasks, voting strategy involve random division of tasks to group members without considering knowledge possess among group members. Whichever tasks that they got from the results of voting, the group members deal with the tasks responsibly. Here are some excerpts to verify the statements:

> "The task division is done by doing the voting, and within the group, there are sub-groups in which two group members are working together

on the same tasks the voting will be use to form the sub-groups as well." (IV_3)

"The task is first divided based on the voting strategy, and also the group members capability, and consider equal distribution of the burden." (IV_2)

Voting strategy for task division is ideally a good way to divide the tasks since group members can learn new thing from the tasks given. However, the groups run the risks of improper completion of the projects because the task is not necessarily given to group members that are expert in it. A student confessed that when the deadline is approaching and the task is still not there, the group decided to give the task to the group members that are more knowledgeable to deal with it. Both strategies have pro and cons and it is influenced by the composition of the group members, availability of time and the current need of groups. Normally students will do the voting strategy at the preliminary weeks of the semester and will use the group member´s expertise towards the end of the semester if they feel that the group project do not meet the requirements.

In the Pv course, the first year students were taught on using different project management tools to help them manage the group projects. The project management tool may include, group written agreements, timetable and group strategies. From the interviews, the use of project management tool is associated with the practice of good project planning and more organized learning. In the group written agreement, the group members explicitly indicate rules and regulation that a group member should obey such as the meeting time, the duration of discussions, what should be done and the focus of the discussions. Each group members should put their signature on the agreement. Normally the written agreement was developed during the preliminary weeks of the semester to help group manage the group dynamics. The following excerpt exemplifies the content of the written agreement:

"In the written agreement, we meet here (in the group room) at 9.15am, every Monday to Friday, and if you are unable to attend, you have to give the calls, only in case of sickness, and then of course after a lot of sick days we have to decide, whether he is trying to run away, or do not do the work, so this is the general rules before starting. So this was made in the first week. And also we have some rules for those who smokes. Because we are not allowed to smoke inside…We also have break for 5 minutes for every hour. And then we have the lunch break." (IV _5)

From the excerpt, the groups are using the written agreement to determine group activities at the specific time frame, group rules and regulations that need to be aware of. To some extend, the group agreement is use to clearly spell out fined imposed to the group members who break the rules. From the interview excerpt:

"For example, what happens when a person come late to the discussions, or not doing their job, we had a jar, of you late for sometime to attend the meetings, there are amount of money that you have to give to the group in the jar, and the group will spend the money together, and also how we keep each other updated, and how do we divide the tasks, so it was basically like that." (IV_3).

The timetable is use to plan the group activities according to the timeframe or weeks. Group of students clearly laid out what they should done in the first three weeks and what should be the focus of the group towards the conclusion end of the semester.

For example, a student (IV_5) revealed his group plan is "*to collect the material, knowledge and problem statements during the first few weeks*". Depending on the group, the timetable could be plan more comprehensive and holistic. A group includes all the group planning in their time table such as the whole plan, the different deadline for both the courses and the project, time management, examination and data collection for the projects. Students also clearly indicated that it is important to properly plan what a group should do at the beginning of the semester, so that they can execute whatever they plan to do, and not to experience the workload at the conclusion of the semester to complete the tasks. Therefore, the project management tool could be use in different ways and in different level. In general, the project management tool helps in organizing group work in a PBL learning environment like in AAU. Student also found that the Pv course is useful for them in organizing different schedules, different methods of dealing with projects and proper work planning. While project work is given the priority in planning the timetable, emphasize should also be given to individual courses attended. Since these individual courses also have their own tasks and deadline, make it more explicit in the timetable along with the project work time line would be useful for better time management. A student (IV_1) remarked that as the consequences of improper planning in the timetable, the group became "*chaotic, misunderstanding and less motivated."*

3.2 Students´ Reflection on PBL Learning

Data for students' reflection on collaborative group learning are mostly obtained from the second interviews whereby they were invited to reflect on their learning experiences from different perspectives. Students were all aware that they need to improvise their group learning process as this is the key to a success PBL group learning. In particular, students´ reflection on collaborative group learning is divided into three sub-theme; timetable, group members and group learning process. In planning the group activities, students in AAU are encourage to use the timetable and it is rely upon the groups on how to plan their timetable. Reflecting on their group timetable, students realize their timetable should not only consist of project work planning, but also should include assignments from the courses. In addition, students are also in agreement that the timetable should be more specific and pragmatic. These excerpts exemplify those claims:

> "With regard to time schedule, we should be more precise in the beginning, we should know that other classes are also take considerable amount of time, and we should make a proper plan according to those." (IV_2)

> "Yes we have the timetable but still we need to plan a lot better (to properly plan) like our scheduling, should still be a lot better, also we should structure our work a bit more." (IV_4)

> "Yeah more specific. Because in timetable, we just wrote that..okay, this is to get the materials, this is to read, and we do not go for more specific than that. We can make our timetable more specific such as clearly suggest where to get materials and sources for our projects". (IV_5)

In AAU first year studies, students do not only responsible on their projects, but also parallel courses to support their project progression and completion. These courses have its own assignments and deadlines too. Therefore, to be more pragmatic in planning the timetable, students should include these deadlines as well to avoid any backlog towards the end of the semester. Therefore, a holistic and integrated timetable that include both

group project and courses deadline is deemed important for a good group planning. Reflecting on the rapport and roles among the group members, students indicated that they should plan more social activities to strengthen the bond between them. Better relationships among the group members would enhance group discussions since the group members become more tolerable, open to criticism and gain mutual trusts. Here are the sample excerpts related to those claims:

> ”If I started all again, I will spend more time to do outside of the room activity with my group members, like being more social together, if that is something that I could change, I would like to change.” (IV_2)

> ”The leadership role is very important, it is very important to have a good leader in the group, that will really improve the performance and the effectiveness of how people work, it could be our leader that can inspire, someone that can maintain the bond among us, or someone that can manage or it could be someone take initiate within the group.” (IV _6)

For first year students, AAU organized a field trip for students with the aim of enhancing the rapport not only between group members, but also between groups. The field trip also focussed on the social and team-building activities for group members to better to get to know each other. Other than that, groups also take their own initiative to meet up during the weekend and spend time together. With regards to the role of the group members, the above excerpt indicated that student see the importance of leadership roles in his group. It is also observed that leadership roles move from one member to member, depending on who contributed the most feasible ideas or strategies. An effective PBL group is defined by combination of different roles and responsibility and not merely rely on good leadership roles. Group members should take different roles during the discussion and this roles should be rotated among the group members. Therefore, each group member will learn on how to manage the group discussion in different ways and contribute from different perspectives. Reflect on the group members commitment, a student remarked that his group members should be more committed to follow what they had plan on the timetable. Here is the related excerpt:

> “We are a kind of behind the schedule we should be better to stick to what we had plan and the deadline that we set up, mostly due to the break, so we had the hard time to catch up, getting back the motivation”. (IV_1)

Planning a good timetable alone is not sufficient to secure a smooth group learning process. Group members should have vision, pragmatic plan and motivation to achieve what they had plan in it. It is prevalent from the excerpt that failure to follow the plan will lead to drain in motivation due to the backlog. A student (IV_5) justifies how a proper group learning process could enhance group members´ motivation working on projects. His group started the discussion with one of his group members wrote on the whiteboard on what they should do for today. In his opinions, it is better for his group to plan ahead *“ok…these are the thing that we wanna do tomorrow, instead of talking this is what we gonna do today.”* Planning a day earlier on the tasks that the group should executed will make group members conscious, prepared, motivated and have better mental readiness. With regards to the group discussions, a student confessed that his group should emphasize more on the quality of the content of the discussions. The following excerpt exemplifies the claimed:

> "Should emphasize on the quality and variability of the ideas from all the group members, rather than want to complete the tasks quickly." (IV_3)

From the excerpt, it is apparent that the group have insufficient time to complete the project work. As a consequence, the group have no choice other than the desire to finish the discussion as soon as possible and simultaneously run the risks of having less quality of discussions because the information is not properly ´digested´ among the group members. While collaboration is inherent in PBL learning process, it is group members who must establish an effective and collaborative group environment. A student (IV_6) observed that each group members should *"keeping a log of what is actually happening day by day so we can keep track on that. So we can use that as part of the reflection."*. This is a good idea in enhancing the group learning process since reflection create cognitive awareness among the students. According to Hmelo-Silver (2004), reflection helps students to relate new and prior knowledge, mindfully abstract knowledge and understand how their learning and problem-solving strategies might be reapplied.

3.3 Impact of PBL on Student Learning

PBL emphasis on the group learning and group collaboration to achieve group learning outcome, which involve dealing with the group project in the current studies. Learning process in PBL that involve application of prior and new knowledge to problem solving, reflection on the processes, actions and outcomes and self-directed learning are all linked to the impact of learning as perceived by the students. The impact of PBL on student learning can be classified into three sub-themes; skills acquisition, peer learning and meaningful learning. Students were aware about the skills they gained throughout the semester such as communication and problem solving. Following are the related excerpt:

> "PBL improved and polished my communication skills. Be more professional, do not mixed the learning with our personal matter or make our project in sluggish way, I also learn on how to stick to the plan that we had made before, and off course I got the skills on problem solving as well."(IV_1)

> "I think I learnt how to manage and solve the problems, and I´m confident in my communication skills. how to face it and then find the solutions. Also how to work with different people, how to react and sometimes it is just better to...like..it depend on the situations." (IV_3)

Effective communication in group learning like PBL is highly important since knowledge is collectively constructed among the group members through discussion. The nature of PBL approach that is interdependent requires active participation and contribution from all learners. To deliver and argue their thought and ideas about issues, students in PBL communicates. A student (IV_6) further remarked that communication should be happened with all group members to avoid any confusion. In his group there is an occasion whereby *"…only two people discuss with each other, and all are more upon them, rather than the rest of the group members, it will create like a kind of gap if we do not communicate effectively in the group".* This excerpt indicated that discussion should be made to known to each of the group members so that no one is left aside. During the discussion, students realized that they mutually learn from each other. The mutual learning occur when student learnt from each other and correcting the mistakes of other group members. The following excerpts confirmed the claimed:

"We (are) also very good at correcting and reading through each other tasks, so if someone has written something, I´m the one who normally corrected, and if there is anything missing, I´m the one who pinpoint on it." (IV_1)

"You work with other people, and you can learn something from them, and teach them, both sides (himself and the group members). So the both sides can take the advantages." (IV_3)

"If you just go solo (individual) on an assignment like this, you will never get anyone else point of view, and I didn´t think about to write the reports, some tips I have about the writings, and add with their own tips, so... I learn more from my group assignments because you never learn much by listening (merely) to your own self." (IV_5)

Therefore, learning is not individual and private since the knowledge is shared and developed mutually among the group members. No decision is made individual since every single decision is taken after a series of discussions and every group members are accounted for any decision made within the groups. Consequently, no one is left out since all group members are well-informed on what is being discuss in the groups. Learn from group members and correcting group member´s mistake lead to the improvement of variety of opinions and ideas. The knowledge that developed helped students to achieve group goals for learning, and thus, was collectively owned by group members. This is one of the main goal in PBL whereby student feel the ownership of what they have learned in the class. A student (IV_3) explained that although *"we have quite different learning style, but we still can cooperate and together we became learning community within our group"*. Another student (IV_5) internalized this collectively constructed knowledge and apply the learning in different context. This student further observed that he is able to transfer knowledge and skills acquired within the group to other learning environment*"actually we do the improvement of the ideas by discussing. We talked about it, we try to put the current knowledge in our context to obtain better understanding"*. By linking what they have learnt from the group learning to other context or in daily life, students found that their learning is more significant and meaningful.

CONCLUSIONS

As Aalborg University implemented project-oriented problem based learning (PBL) in its programme, the first year of undergraduate studies is devoted for students to get accustomed with PBL ways of learning. This paper explore students learning experiences in AAU PBL learning environment that focus on group strategies, reflection and impact of learning. Apparently, social learning that involve brainstorming of the ideas, equal division of the tasks among the group members and application of project management tool are group strategies used by the groups to deal with their project work. From their reflection, there are several areas that has been identified need to improve, including planning for a more specific time table, be more social with group members and emphasize on the quality of the discussions. PBL impacted student learning in terms of gaining the skills, learned from group members and a meaningful learning experience. These information on how first year students experience PBL is an important piece of information for the teachers intend to implement PBL in their courses.

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Appendix L: Article 4: ***Addressing the Contextual Elements and Developing Initial PBL Design: Lesson Learned from Three Asian Universities***

Addressing the Contextual Elements and Developing Initial PBL Design: Lesson Learned from Three Asian Universities

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Problem Based Learning (PBL) approach has been perceived as a feasible teaching and learning alternative by many Asian universities to adapt because of its promise to foster active learning. However, implementing PBL in Asia context requires a considerable adjustment according to specific needs and norms of an institution. Therefore, Design Based Research (DBR) is deemed as a feasible methodology in addressing this issues. The main aim of the article is to tell the stories of the local constraints and drivers from Malaysian, Indian and Thai case. These information inspired development of initial PBL designs for each cases. Across the cases, administrative supports, staff development, student readiness of change and innovation in curriculum appear to be the common contextual factors. Addressing these contextual factors during the preparation phase lead to the development of initial PBL design that sensitive to specific needs and norm for each cases (145 words)

Keywords: problem and project-based learning; design based research; preparation phase; contextual elements; initial PBL design.

1. Introduction

Problem Based Learning (PBL) as an education strategy has progressed well and embraced by many leading universities around the world. Since its first employment about 40 years ago in a medical educational programme at McMaster University (de Graaff and Kolmos, 2007), PBL has evolved in many institutions worldwide and applied in variety fields regardless of disciplines and geographical boundaries. Despite a variety of aims, designs and practices, de Graaff and Kolmos (2003, 2007) define a common PBL learning principles that derived from PBL models and learning theories. The PBL learning principles can be divided into three approaches of cognitive learning, collaborative learning and contents:

i. The **cognitive learning approach** means that *learning is organized around problem* and will be *carried out in projects*. The problem is the starting point of the learning process, place students to learn in context, and learning is based on students´ learning experiences.
ii. The **contents approach** concerns with *interdisciplinary learning* that involved divergent of the subject related boundaries and methods. The contents approach also emphasize on linking the theory and practice
iii. The **collaborative or social approach** involve *team-based learning* whereby learning occur through dialogue and communication between group members. Students learn from each other by sharing the knowledge and organizing the group learning process.

Over the last decades, many Asian countries have implemented PBL because of its promise to foster active learning and self-directed learning. Shifting towards innovative and student-centred approach to teaching and learning like PBL in Asian higher education is largely contributed by the changing the policy and to better prepare the graduates with skills and competences. However, since PBL was originated from the western higher education institutions, adapting PBL in Asian context requires considerable change of the curriculum in order to fit with the needs of local needs and norms, as stated by Kolmos et al., (2009):

> In engineering, the practical are quite different from those in the health sciences and the cultural values in Asia or South America result in different communication patterns and decision strategies on teams. As a consequence, it is not possible for Asian or South American universities to copy a western curriculum and learning approach (p.10).

This statement implies the need to adjust and address contextual concerns according to the discipline and specific countries, rather than emulating an intact PBL curriculum from specific institutions. In wider perspectives of curriculum design, emphasizing the needs on educational goals, social, political and economic traditions, and cultural aspect of a particular institution is very necessary (Kolmos et al., 2009). Similarly, Stojcevski and Du (2009) claimed that designing a PBL curriculum is dependent on the objective of particular institutions. A comparative review study by Khoo (2003) on PBL implementation across Asian nation including Malaysia, India and Thailand provide insights on compatibility of PBL and Asian cultures. Collaboration among group members for learning, self-management and self-discipline were among the Asian values that are favourable to PBL and could be the drivers for the implementation (Khoo, 2003). However, higher reverend towards teacher and authority and fear of confrontation and open criticism towards teachers that entrenched in Asian culture could serve as potential barriers to PBL implementation. Likewise, Hussain et al. (2008) studies on issues and challenges of PBL implementation from Asian cultural perspectives revealed that critics to peers and facilitators is deemed inappropriate despite being critical is highly desirable in a PBL learning environment. Therefore, readiness of both teachers and students is highly important before any implementations taking place in Asian context. Since PBL involves a significant shift in the roles of teachers in classrooms and ways students gain knowledge and competencies. An envisioned learning trajectory should include a plan to support both teachers and students. Therefore, a specific research

methodology is needed to adjust the PBL model in an effort to reach a PBL model that is compatible with Asian higher education. The methodology should allow the inclusion of local need and norms during the design process. Searching for the design research domain, we came across with Design Based Research (DBR), which is a relatively new yet promising research methodology to attend those mentioned challenges. The following text discusses DBR as a suitable research methodology in addressing concern of designing and enacting teaching and learning innovation like PBL that are theoretically grounded and co-constructed in real-world context.

2. Design Based Research (DBR) as a Research Methodology for PBL Design

Design Based Research (DBR) can be seen as an amalgam of research methodology and research framework. DBR is used as a research methodology for understanding learning in the complex environment, or engineering new learning environment to improve the learning of the participants in the environment (The Design Based Research Collective, 2003). Wang and Hannafin (2005) define DBR as a systematic and flexible research framework aimed to improve educational practices through iterative analysis, design, development and implementation, based on collaboration between researchers and practitioners in real world settings. Researchers contribute in the rigorous research methodology while practitioner e.g. local PBL practitioners provides understanding of the context that may include local issues, barrier to the local setting and highlighting participant concern. Therefore, close collaboration between both parties is essential to obtain a PBL design that corresponds to the local needs and norms. As a research methodology, there are several phases and typical activities proposed by DBR advocates (for example see Hoadley, 2002 and Edelson, 2002). After a careful selection, current research is adopting Cobb and Gravemeijer´s (2008) phases and activities for conducting a design experiment. The methodology, as suggested by them is divided into three phases:

i. Phase 1: Preparing the experiment
ii. Phase 2: Experimenting to support learning
iii. Phase 3: Conducting retrospective analysis

However in this article, we focused the discussions on the *Phase 1: Preparing the experiment* that account for the initial PBL designs. The initial PBL design is focus both on the robustness of the theory and the influence of contextual elements and deliberately flexible yet consistent to allow change being made when necessary during the subsequent phase. As the research progresses to the development and the enactment stage, the emphasis will focus on the feasibility of the design. Correspond to this process of convergence between design research, theory and practice, it is expected that the final design is contextually-sensitive, theoretically-sound and sustainable. Finally, the optimized, contextual-based PBL designs will have more possibility to sustain and become an integral part of pedagogical practice in Asian institutions.

This paper reports on the initial PBL designs that derived from the preparation phase of design across three Asian higher education institutions from Malaysia, Thailand, and India. Malaysia is represented by Universiti Pendidikan Sultan Idris (UPSI) which is implementing PBL in its teacher education program. Singhad Institute of Technology (SIT) is the Indian case study which focuses on the implementation of PBL in mechanical engineering. Finally Thailand case study is taken from the English as Foreign Language

(EFL) from Mae Fah Luang University (MFU). The emphasis of the preparation phase of PBL design is upon identifying constraints and drivers of PBL implementation in each local context (Malaysia, India and Thailand). Upon developing the initial PBL designs for each case, it will be use as a point of departure in developing the PBL designs for each individual context. Identifying local constraints and drivers and address it in the initial designs are important preliminary steps in optimizing the PBL designs in the later stage of the study. The following part discusses, compare and contrast local constraints and drivers for each case.

3. Local Constraints and Drivers for PBL Implementation

Local constraints and drivers are drawn from author´s experience as teacher/lecturers at Asian universities, university´s values and ethos, Ministry´s report on the current educational policies on higher education, literature review, and academic discourse with colleagues. The objectives of PBL design in the respective cases are depicted in Table 1:

Table 1: Objectives of PBL implementation in three Asian cases.

Country	Objectives
1. Malaysia	To improve students´ learning, and inculcate skills and competencies
2. India	To improve students´ learning, and inculcate skills and competencies
3. Thailand	To empower both teachers and students to acquire learning experiences which stimulate application of knowledge and skills to novel situation

Table 1 demonstrates that the objective of the Malaysian and Indian PBL designs are similar which focus on student learning. However, the Thai PBL design is broader and holistic because it is also includes the training of teachers. In each case, the PBL design is planned to be carried out for one semester (approximately 14 weeks). The following section presents the discussions on the local constraints and drivers for feasible implementations of PBL design in the respective case studies. The local constraints and drivers are reported from seven distinct perspectives which includes; administrative system and supports, motivation for PBL implementation, curriculum and course structure, teaching and learning culture, resources and facilities, student background, and facilitation styles.

3.1 Administrative system and supports

The Asian higher education structure is highly top-down that reflect support from top level university administrators is crucial prior to initiate the change made in university pedagogical approaches. In the Malaysian context, the policy towards Outcome-Based Education (OBE) has been introduced by the Malaysia Quality Agency (MQA) since late 1990s (Puteh et al., 2013). This gave rise to PBL because it is considered as one an OBE approach (Pelan Strategik Pengajian Tinggi Negara,

2007). The Indian context adopts a different approach whereby the university is very strict on the changes made in the pedagogical approach. Hence, teachers cannot freely conduct PBL sessions in their classroom without proper instruction from the top managements. This has resulted in slow adaption of PBL or any other student-centred approach in the Indian institution. The Thai context is rather similar to the Malaysian case whereby the university supports innovative pedagogical approaches such as PBL. However, it should not exceed lecture time allocation for each subject. This is because newly implemented approach might affect space and time allocation such as rooms, time slot and lecture periods. Therefore, for both Malaysian and Thai case, support from the administrative is already there whereby for Indian case, permission need to obtain from the administrative before any implementation taking place.

3.2 Motivation for PBL implementation

The aims of PBL implementation in all three cases are to improve student competence profile in each discipline and to shift the focus from passive learning to active learning. In the past, PBL was found suitable to improve students' competence profile in Malaysian (see Sharifah and Lee, 2005; Mohd-Yusof et al., 2005 and Said et al., 2005) Indian (see Mantry et al., 2008, Singh et al., 2008, and Abhonkar et al., 2011) and Thai context (see Hallinger and Lu (2011) and Coffin, 2013). The ministry of higher education in Malaysia has changed their policy to adapt outcome based education (Puteh et al., 2013) and this has provided an extrinsic motivation to adapt PBL in its higher educations. In addition, the Ministry of Education has listed intended professional competence for the Malaysian teachers, for which PBL is thought to be suitable alternative.

In Indian context, motivation to implement PBL is provided by the government reports and industry demands for competent graduate engineers (Blom and Hiroshi, 2010). Like Malaysian government, Indian government is also decided to adapt outcome based education in engineering education. In fact, both countries are the members of Washington Accord. Therefore, for Malaysian and Indian context motivation to adapt PBL is provided from policy change of the government. However, for the Thai context, the motivation is provided by the MFU executive managers who wanted to raise the academic standards at the university and promote application of the knowledge. Despite the motivation that came from the top management and policy, motivating the teachers and students could be major a challenge to implement PBL since the role of teachers and students are changed in PBL. Within three cases, exposing teachers and students to a new teaching and learning approach such as PBL might dampen their motivation since they are not acquainted with PBL approach. To sustain their motivation, community of practice among the teachers should be establish to bring forward the change especially in Thai case that aims PBL implementation at programme level. In conclusion, motivation and drivers from both top management and those in the grassroots level are important for a successful PBL implementation in Asia.

3.3 Curriculum and course structure

In all three cases, content of the course or the program is central to teaching and learning approach. In order to make sure that all listed contents are covered, lecture-based approach seems to be dominating in these contexts. Teachers and students in these contexts eventually become quite comfortable with this approach because it is predictable to them. The concept of PBL is considered relatively new to both teacher and students in these three contexts, but somehow top managers of these three contexts believe that PBL can raise their academic standards, and consequently will improve students' learning outcomes (abilities) or performance. In the process of redesigning a PBL course or curriculum, reallocating time for PBL lessons or activities within the existing course structure is applicable across the three cases. However, the issue of flexibility in redesigning course content is not applicable in India context. The educational setting of Malaysia and Thai contexts allow some flexibility in rearranging and modifying the content of the course to be learned in PBL way. In contrast, Indian educational setting do nor offer such flexibility to the teachers because of a more rigid structure and hierarchical management system at the university level. Moreover, the three cases also agree on the drawback that PBL increases the workloads for both teachers and students when introduced in existing state. Even though the three cases appear to have a rigid course or program structure to some extent, within that rigid structure there is a room to integrate PBL at different levels. This is the challenge for both researchers and teachers to be creative in their decision making.

3.4 Teaching and learning culture

Both teacher and students of three cases are in a comfort zone of traditional learning and teaching approach, rote learning and lecture based approach. Therefore, when shifting to PBL, a shift in the roles of both teachers and students is required which will bring them out of their comfort zone. Consequently, resistance from both agents is expected to some extent. Malaysia, India and Thai education systems appear to give importance to grade because it is viewed as the measurement of students' achievement and quality. In contrast to education values of the three cases, learning process, as contrast to the learning product, plays a crucial role in PBL approach to learning. Therefore, the established learning principles in three cases and learning principles in PBL to be in conflict. In all cases, it is recognized that the mind set of academic staff is the most important key element in initiating change process to PBL. Bringing together those who have the same mind set towards PBL will initiate a community of practice and consequently this community will maintain the PBL practice. Implementing PBL is not about only understanding the concept, but it is about how to actually put the understanding of concept into the actual practice. Getting the teacher and student out of their comfort zone to practice PBL is a

challenge for all cases either to initiate or maintain PBL implementation. Therefore, the incentive dimension is the issue that each contexts need to reflect upon.

3.5 Resources and facilities

In the earlier section, we have discussed motivational aspect of PBL and mentioned about incentives for PBL activities. Though top managers decides to implement PBL, this change has to be supported through appropriate changes in the resources and facilities which may include staff, materials, space, and finance is useful to support traditional pedagogy. The practice of PBL is relatively new to all the cases. Therefore there is an issue of training and preparing the academic staff and creating teaching learning resources related to PBL. The issue of staff could be resolved through staff training and orientation workshops. Incentives for those who are willing to adapt their teaching and learning practice with the PBL approach might potentially encourage dissemination of PBL. This incentive is a particularly important concern for institutions that are still at infancy state of PBL adoption as demonstrate by all the three cases. Facilities such as lecture room, tutorial room and group room are the major space required for teaching and learning to take place. Though all three institutions are well-equipped with lecture and tutorial rooms, availability of private group rooms for students in Asian context is most unlikely event to occur. The issue of learning space could be resolved by effective and innovative use of available space. For example, space or small rooms could be reserved at the library or reading hall for group work. Existing facilities could also be manipulated to create a PBL learning environment. For example, in all three cases, the lecture rooms are often equipped with movable chairs with a small table attached to it. The chairs could be arranged into circle for students to do the group discussions. Another issue is financial support for preparing a change to a PBL approach. Developing teaching and learning resources and teaching aids might require provisions to be included in the budget.

3.6 Student Background

One criticism of PBL implementation in Asia higher education is that students do not actively participate in group discussions (Khoo, 2003). Students in all three cases are very much familiar and comfortable with conventional, didactic ways of learning that involve memorization, recall the information and passive involvement in the classrooms. Their background is contradicted to PBL that emphasize on creative and critical thinking, reflection and active participation during learning. Current Malaysian university students have a minimum of 11 years of traditional schooling at primary and secondary level. In India, engineering students have at least 12 years of school education at primary and secondary level. Likewise, in Thailand the majority of students tend to be passive learners in which they have been trained for at least 12 years of acquiring knowledge by transmission. Teachers are expected to sole-provider of the knowledge to students and they are expected to reproduce the

transmitted knowledge. Knowledge construction as devoted in PBL is definitely beyond their comfort zone. Our exam-oriented, grade-emphasis school system is less favourable to deep understanding and skill development as demanded in PBL. With regard to these previous schooling background, it is important for us to prepare our students before embarking on PBL practice. Furthermore, Dabbagh et al., (2000) reported students who are new to PBL setting, experience discomfort and frustration at the initial stage of learning. Preparing the students can be in the form of facilitation style, PBL problem formulation and group dynamics. At the beginning of the semester, a more structured and explicit facilitation with highly structured PBL problems might be a feasible strategy to ease student discomfort.

3.7 Facilitation style

In a typical PBL class, a tutor or facilitator is assigned to a group of student to better facilitate and support students´ learning. However, this is not feasible for PBL implementation in Malaysia, India and Thailand since there is only one teacher to teach a specific course. To offset the shortage of facilitators, floating tutor to facilitate students learning is employed in Malaysian context. The facilitator will go around the groups to facilitate group work, and probing students´ group with questions that lead students activating their prior knowledge and experiences. Each group is also required to keep group´s logbook and reflection notes to monitor periodically their progression and to determine further scaffolding needed by each group. In the early semester, intense and more structured facilitation style will be adopted to help students in their learning, and a more independent and less structured of facilitation will take place as students become more accustomed with PBL learning. In Thai context, the teachers have a flexibility to reorganize the allocated class time. Therefore, PBL teachers are allowed to minimize lecture time from 45 hours per semester to 12-15 hours per semester. The other 30-33 hours are spent on PBL activities, including project management workshop, self and peer assessment workshop, and also facilitation. Moreover, students are required to do self and peer assessment monthly. They do not use logbook, but they are required to do panel discussions which observed and facilitated by the teachers. The panel discussions allow students to report and exhibit the progress of their work and their learning periodically.

4.0 Initial Designs for Malaysia, India and Thailand Cases

Upon identifying, comparing and contrasting constraints and drivers between three cases, the initial PBL designs is developed based on Cobb and Gravemeijer´s (2008) framework for preparation phase in design research. Cobb and Gravemeijer (2008) divided preparation phase into four parameters; Clarifying the instructional goals, documenting the instructional starting points, delineating an envisioned learning trajectory and placing the experiment in theoretical context. Common to all the three cases, it is pertinent to *clarify instructional goals* of improving learning, by examining curricular documents and goals. In *documenting the instructional starting*

points, we construct assessment procedure aims to determine students´ cognitive level and what students "typically learn in the class" (Reimann, 2011). Identifying student cognitive level and learning will provide insights on the initial PBL designs on facilitation style, PBL problem formulation, learning trajectory and assessment procedures suitable to them. PBL involves a significant shift in the way students learn and how the content is delivered. An *envisioned learning trajectory* is an explanation of expected learning process that will happen in PBL class that includes pattern of communication, learning sequences and delivery of PBL problems. This in turn will yield a design feasibility to *place the experiments in a theoretical context* to ensure that the initial PBL design is aligned with theories that underpins PBL.

4.1 Initial PBL Design for Malaysian context

Table 2: Activities involved in initial PBL design for Malaysian context

Parameters of preparing experiment by Cobb & Gravemeijer (2008)	Actual activities and parameters of the preparation phase used in designing PBL curriculum
1. Clarifying the instructional goals	• Focuses on learning objective of the faculty and learning outcomes of the courses • Inclusion of skills and competences in learning outcome to align with the PBL curriculum • Constructive alignment between course content, teaching and learning objectives and assessment strategies
2. Documenting the instructional starting points	Obtaining inspiration for PBL curriculum development from theoretical and contextual practices a)Theoretical inspiration • Review of PBL implementation in Malaysia on implementation issues and learners´ experience • Review of PBL implementation in teacher education field on specific consideration and the effects. b)Contextual inspiration • Case study on exemplary practice of PBL • Close collaboration with the practitioner to determine possibilities, affordance and challenges from contextual practices.
3. Delineating an envisioned learning trajectory	Preliminary draft of PBL curriculum that consider: a. Roles of the actors b. The cases/problems as the ways of organizing curriculum

	c. Contextual norms d. Assessment strategies
4. Placing the experiment in a theoretical context	A complete plan of instructional design for a specific course in teacher education fields. Each perspective of instructional design corresponds to the theoretical underpinning PBL and contextual concern.

In Malaysian case, the existing learning outcome is modified to include skills and competences that aligned with the PBL learning principles. These new learning outcomes serve as a point of departure to plan for the teaching and learning activities and assessment. To assist in planning for teaching and learning activities, and simultaneously aims at achieving the learning outcomes, the inspiration came from theoretical and contextual elements that had been discussed earlier in this article. By including both elements in designing PBL teaching and learning activities, it is hope that the PBL designs correspond to local need and maintained the rigorous of learning research. To delineate learning trajectory, it is important to spell out the role of researchers and students, the gradual introduction of PBL problems to students and how to executed the assessment that comply with the PBL approach.

4.2 Initial PBL Design for Indian context

From above discussion, it is evident that there are multiple challenges and constraints for PBL implementation at SIT. Despite with these constraints there are many possibilities and ways by which PBL can be implemented. Reflecting on the constraints and their scale, it is thought that small scale PBL activities will be a good starting point for Indian case that involve group work, collaborative learning in the laboratories and project competitions. This way PBL can be implemented without changing the curriculum content and institutional setting. Understanding SIT context derived from an analysis of Indian context, experience from a case study, and reading from literature guided me to take the decision to start an experiment in my course. This guided my PBL experiment design. Specific tasks and activities which are completed as part of preparation phase for a design experiment are tabulated in the following table:

Table 3: Tasks and activities in DBR´s preparation phase for PBL implementation in India

Parameters of preparing experiment by Cobb & Gravemeijer (2008)	Activities in the task
1. Clarifying the instructional goals	Problem design includes the choice of the type of the problem and difficulty level, specifying the students´ proposed activities, aligning course objectives and project activities
2. Documenting the	

instructional starting points 3. Delineating an envisioned learning trajectory	• Assessment of Students' current capabilities and availability of time and time required to complete the problem. • Development of envisioned trajectory or holistic plan of student's learning
4. Placing the experiment in a theoretical context	Plan of implementation • Deciding course and class for implementation and the duration of implementation.
	Plan of assessment and data collection • Designing learning outcome assessment strategy • Designing instruments for assessment of learning outcomes • Specifying the time of assessment and data collection Specifying the role of technology for data collection
	Plan of data analysis • Data coding and decoding procedures • Deciding the software or means of data analysis

After careful study of the Indian educational culture, I decided to take a bearing on myself by designing my own course on a PBL approach. Furthermore, it makes lot of sense to experiment at the course level and then gradually institutionalize PBL implementation. This decision has given me a flexibility to design, test and research on the PBL approach in my course and exposed me with experience of designing a course which I never did before. The dream of institutional PBL model seems to be distant. Till then there is a need to keep on experimenting at the course level. So far I have designed two courses on PBL approach and successfully implemented. Data from these two course level experiments have suggested that students enjoyed new curriculum setting and new way of learning. Due to my results and students experiences, other academic staff are showing interests and be ready to implement PBL in their courses. So far, we have developed two course designs and able to change the academic practice. This small initiative of change is hope to bring the dream of Institutional PBL model to reality in the near future. Till then, it is important to keep on experimenting and refining the PBL designs. Certainly, the initial research activities during the preparation phase of design based research influenced my decision to apply PBL at a course level and consequently guided the curriculum design and implementation process.

4.3 Initial PBL Design for Thai context

The framework of preparation phase of design-based research (DBR) by Cobb and Gravemeijer (2008) has been taking a significant important role in the curriculum design process of the PBL curriculum for EFL interdisciplinary studies. In addition to the framework, there are some other aspects have also been included in the design framework of the Thai context, details as follows:

Table 4: Activities in initial PBL design according to parameters of executing experiments for Thai context.

Parameters of preparing experiment by Cobb & Gravemeijer (2008)	Actual activities and parameters of the preparation phase used in designing PBL curriculum for EFL interdisciplinary studies
1. Clarifying the instructional goals	**Analysis of practical problems by the researcher** • Alignment between educational goals, expected learning outcomes, and other elements of the curriculum • Identifying students' current learning in the context of the current used of teaching methods ***[documenting the instructional starting points]***
2. Documenting the instructional starting points	**Exploring possible solutions** • Literature review • Documentation and participation in workshops and seminars of curriculum development • Conducting case studies to inspire and support the new curriculum model • Designing the general framework of the curriculum or curriculum prototype ***[delineating an envisioned learning trajectory]*** • Negotiation with executive managers and lectures (bridging an understanding and an expectation from both sides)
3. Delineating an envisioned learning trajectory	**A collaborative design of the semester module (curriculum)** • Involving lecturers in the curriculum design, co-designers ***[placing the experiment in a theoretical context].*** • Clarifying the semester educational goal, learning outcomes, content, teaching and learning method, and assessment ***[clarifying the instructional goal]***.

4. Placing the experiment in a theoretical context	**A concrete result from the preparation phase** A handbook of guidelines to the new curriculum and its approach to learning and teaching for lectures (PBL practitioners).

The preparation phase of DBR used in designing a curriculum in a Thai context began with an analysis of the current situation at the institution (constraints and drivers) whereby alignment between curriculum elements are identified and student current learning is determined. Upon performing the analysis the preparation phase involve exploration of the possible solution inspired from the literature, participant in the workshops, conducting case studies, developing framework and negotiating with university top managers. Add onto the parameters of the preparation phase, the design for a Thai context also emphasizes preparing the curriculum design that involve collaboration between lecturers that have same interest in implementing PBL in their own courses. This initial design of Thai case aims at producing a handbook of guideline to PBL.

5. Conclusions

During the preparation phase of DBR, it has been emphasized that contextual and cultural understanding and prior research is necessary to inspire the PBL design. Reflecting on the constraints and drivers, each case poses different challenges on the PBL adoption in their institutions. Be it at the course or programme level PBL implementation, it is important to reflect upon this information by addressing it in the preparation phase. Across the cases, common constraints and drivers might be easy to tackle while the specific ones should be attended carefully to minimize tensions of changing towards innovative learning practice. After a careful studies of the educational culture (administration and resources, curriculum setting and teaching learning etc.) of each cases, these information were use to inspire the development of initial PBL designs from the preparation phase. The dream of achieving the institutional model can become reality only when all the elements of the institute i.e. administration, staff, students, curriculum, teaching learning practice and resources aligned with the PBL approach. Till then there is a need to experiment and continued negotiation and collaboration with all elements of education system to ensure the steady growth of PBL in our educational systems. We hope that our efforts will motivate other staff members to experiment and accept PBL in our cultures. We conclude that the PBL curriculum in Asian context needs to be designed in view of local culture and context. Our collective experience confirms that DBR is a feasible methodology to design, implement, and evaluate PBL curriculum in different contexts.

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Appendix M: The PBL toolkit for PBL1: Constructivism

1. Lesson plan (PBL description)

Course	:	MANAGING LEARNING IN SCIENCE (Pengurusan Pembelajaran dalam Sains)
Code	:	SSB6034
Week	:	4 (17th March 2012)

Elements	**Description**
Topic	Constructivist and non-constructivist teaching practices
Learning Outcome	At the end of the completion of the PBL cycles, students (in group and individuals) are expected to be able to: Knowledge: i. Identify elements of constructivist teaching practices ii. Provide justifications of the constructivist elements identified iii. Differentiate constructivist and non-constructivist teaching and learning iv. Construct an evaluation tool from constructivist perspectives to evaluate a teaching Process and skills: i. Develop skills in searching for relevant information ii. Ability to define what the problem actually is iii. Acquire team skills through group work iv. Demonstrate communication skills through presentation
Duration of problem	3-4 weeks
Level of difficulty	Intermediate
Prior knowledge	-Basic concepts of constructivist theory, concepts and principles -Developing rubrics for classroom evaluations
Problem trigger	A video of 15-minutes duration showing a teacher teach body parts in a public primary school class
Student task	You will see a 15-minutes length videotape showing a science teacher teach about body parts in a public primary school class. Your task is to identify to what extend the teacher employed constructivist teaching and

	learning strategies in her class. You may consider: i- Which practices/activities considered as constructivist ii- How the component of teaching plan of the teacher can be related to constructivist concept iii- Which part of the teaching could be improvised to reflect a more constructivist class iv- Strategies to evaluate to what extend a class could be considered as a constructivist class Use the PBL thinking template to articulate the information from the videotaped.

2. Lesson plan (Pre-determine PBL thinking tool)

Fact	Idea	Learning issues	Action plan
-What do we know? -What fact that can be extracted from the videotaped?	-What do we think? -What is possible explanation?	-What do we need to know? -Put the inquiry into question form	-What should we do? -Which resources are appropriate to approach?
-Start the teaching by singing. The lyrics consist of human body parts -Pupils touch their body parts while singing -Teacher call upon a pupil to show the body parts -Ask the rest of the pupils to spell the body part while showing the words using cards -Teacher call pupil individually to spell the words -Teacher gives envelop consist of alphabet to groups of pupils. - In group, pupils work together to arrange the alphabets. The word that they need to find is actually the body parts. A representative of each group need to attach the words next to the respective pictures on a whiteboard. -Sometimes, teacher praise her pupils -Give homework, a worksheet that pupils need to match the words to the respective picture of body parts.	-The induction set is started with a song -Teacher integrate the body part in a song -To retain pupil´s attention, teacher call student individually -To reinforce the learning, pupils spell the words whilst touching their body parts. -Learning by imitating the teachers and drilling by pronouncing the words for several times -In enforcement activity, pupils work independently (arranging the words, attached the words to the respective body parts) -	<u>Constructivist</u> 1. What are the principle of constructivist T&L? 2. In what way singing session approach constructivist learning? 3. How to create a classroom environment (role of teacher, student, physical facilities, classroom setting) that fulfill constructivist T&L? 4. How do you differentiate constructivist and non-constructivist teaching? <u>Instrument</u> 1. what types of instrument can be used? 2. What would be the best form of instrument? 3. What are the components to be included in developing the instrument for assessing the lesson?	Resources : Books, internet search and journal -Example of preliminary resources?? Group product: Report, presentation, rubric Task division: Who is doing what?

3. Problem Scenario (PBL Trigger)

4. Problem Scenario (PBL Student Task)

BODY PARTS

Watch the 15-minutes length video of a science teacher teaching about parts of the body in your school. You are requested to do a peer review of the lesson and assess the extent in which teacher Jamilah employed constructivist teaching and learning principles in her lesson. Develop an instrument for the review process and explain the elements that were incorporated in it. Use the instrument develop to assess the lesson and present the results to other science teachers in your department. Suggest improvements on how to improve the lessons.

To facilitate group discussions:

i. Appoint a chairperson and a scribe. A chairperson will steer the discussions by encourage members to participate, **e**nsure scribe can keep up and is making accurate record and keep to time. Scribe will record points made by group **and** help group order their thoughts. For the rest of group members, follow the steps of the process in sequence**, a**sk open questions**, s**hare information with others and actively involves in group activity.

ii. Set the group´s discussion strategy such as: To start the discussion by brainstorming, synthesis and analyses each points, sorting out the information based on learning issues, equal contribution of each group members, strategies to divide the task before leaving the class, and resources to approach,.

5. Alternative Assessment (Rubric to Evaluate Oral Presentation)

TRAIT	Explanation of traits and score distribution			Score obtained
i. NONVERBAL SKILLS				
Eye contact	Hold attention of entire audience with the use of direct eye contact, seldom looking at notes	Consistent use of direct eye contact with audience, but still returns to notes	Display minimal or no eye contact with audience, while read mostly from the notes	
Score	5 or 4	3 or 2	1 or 0	
Body language and poise	Movements seem fluid and help the audience visualize. Student displays relaxed, self-confident nature about self, with no mistakes	Made movements or gestures that enhance articulation. Makes minor mistakes, but quickly recover from them, displays little or no tension	Very little movements or descriptive gestures. Displays some degree of tension and nervousness, has trouble recovering from mistakes	
Score	5 or 4	3 or 2	1 or 0	
ii. VERBAL SKILLS				
Enthusiasm	Demonstrates a strong, positive feeling about the topic during entire presentation	Occasionally shows positive feeling about the topic	Shows some negativity and no interest toward topic presented	
Score	5 or 4	3 or 2	1 or 0	
Elocution	Voice is clear and correct, precise pronunciation of terms	Voice is clear and pronounces most terms correctly. Most audience can hear presentation	Voice is low, incorrectly pronounce terms, and speaks too quietly for a majority of students to hear	
Score	5 or 4	3 or 2	1 or 0	
iii. CONTENT				
Subject knowledge	Demonstrates full knowledge by answering questions, with explanation and elaboration	At ease with expected answers, with limited explanation	Does not have grasp of information, able to answer only rudimentary questions	
Score	5 or 4	3 or 2	1 or 0	

Organization	Present information in logical, interesting sequences with audience can follow	Present information in logical sequences which audience can follow	Information is not delivered in sequences and logical way.	
Score	5 or 4	3 or 2	1 or 0	
Constructivist elements	Consist of definition, learning, characteristics, differences, skills and justification	Missing one or two elements	Missing two or three elements	
Score	5 or 4	3 or 2	1 or 0	
Justification	Convincing, strong and relevant	Not convincing enough but still relevant	Not convince and irrelevant	
Score	5 or 4	3 or 2	1 or 0	
Mechanics	Presentations has no misspellings or grammatical errors, layout is clear and easy to follow	Presentations has no more than three misspellings or grammatical errors, layout of most page is easy to follow	Presentations has more than three misspellings or grammatical errors, layout is confusing or inappropriate	
Score	5 or 4	3 or 2	1 or 0	

Appendix N: The PBL toolkit for PBL2: Alternative Conception

1. Lesson plan (PBL description)

Course	:	Managing Learning in Sciences (Pengurusan Pembelajaran didalam Sains)
Code	:	SSB6034
Week	:	9 (21st April 2012)

Elements	**Description**
Topic	Alternative conception in student learning
Learning Outcomes	At the completion of the PBL cycles, students (in groups and individual) are expected to be able to: Knowledge: v. Write a research report on students' alternative conceptions vi. Suggest ways to elicit students´ alternative conception vii. Propose strategies to overcome students´ alternative conception Process and skills: i. Identify reliable sources to write the review paper ii. Ability to conduct individual studies based on the task given by the group
Duration of problem	2-3 weeks
Level of difficulty	Intermediate
Prior knowledge	-Scientific idea of the chosen concepts -Writing research report
Problem trigger	A letter from a journal publisher, *Macrothink* and data from alternative conception research
Student task	You are a team of researchers planning to conduct a review on the research about students' alternative conceptions. Examples of findings from research on concepts related to the properties of light are attached. Your research team has decided to publish the review in the form of a research report in a journal. Refer to the invitation letter and write a research report on a chosen topic in science.

Learning Issues	What are alternative conceptions?
	What are other terms used to describe students' alternative concepts?
	What are the sources for students' alternative concepts?
	How to elicit students' alternative concepts?
	Why do students have alternative concepts?
	How to overcome students' alternative concepts?
	In what ways do students' alternative concepts affects learning?
	What are the science concepts in which research has been conducted on alternative concepts?
	How should the format for the report looks like?

2. Lesson plan (Pre-determine PBL thinking tool)

Fact	Idea	Learning issues	Action plan
-What do we know? -What fact that can be extracted from the collective empirical research findings?	-What do we think? -What is possible explanation?	-What do we need to know? -Put the inquiry into question form	-What should we do? -Which resources are appropriate to approach?
-Student conceptions on things that can produce light is very diverse -Some are correct, some are nearly there and some are totally wrong -The pathway of a light that travels is different among the students. Some thinks that light are travelling in a straight line, other have the conceptions that light are travelling in perpendicular ways	-The research findings showed that students re confuse between light-emitting devise and naturally-produce light -How lights are travelling is also different from the scientific ideas	- What are alternative conceptions? - What are other terms used to describe students' alternative concepts? - What are the sources for students' alternative concepts? - How to elicit students' alternative concepts? - Why do students have alternative concepts? - How to overcome students' alternative concepts? - In what ways do students' alternative concepts affects learning? - What are the science concepts in - Which research has been conducted on alternative concepts? - How should the format for the report looks like?	Resources : Books, internet search and journal -Example of preliminary resources?? Group product: Report, presentation, rubric Task division: Who is doing what?

3. Problem Scenario (First PBL Trigger)

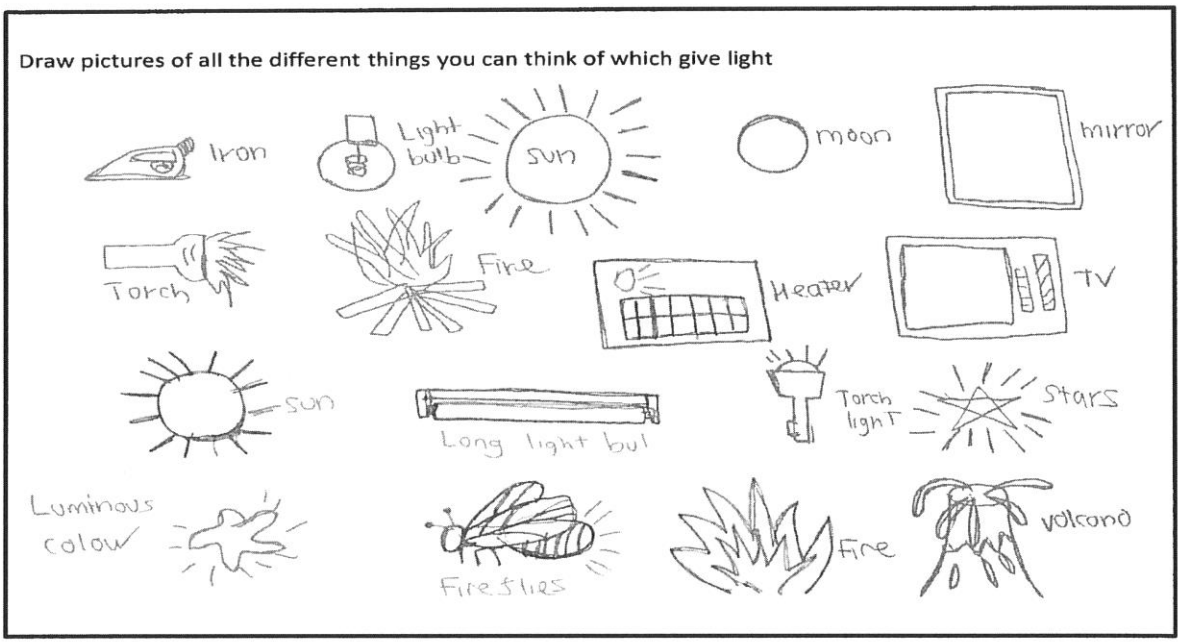


Diagram 1: Collective empirical research findings on student conception of light-producing things

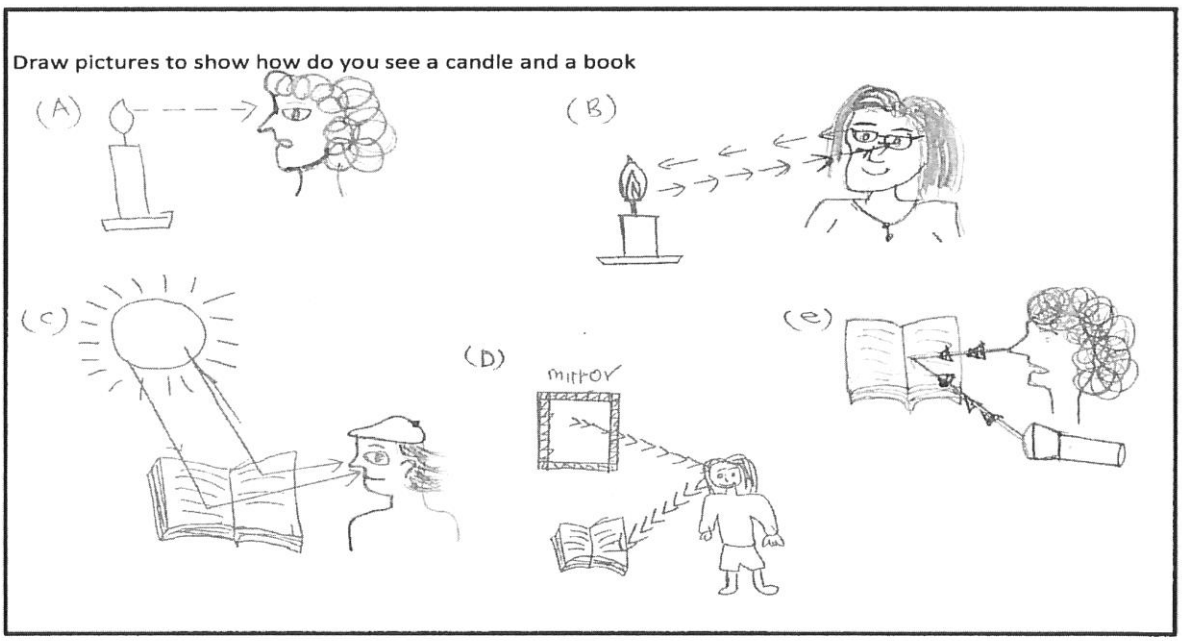


Diagram 2: Collective empirical research findings on student conception of movement of lights

5. Problem Scenario (Second PBL Trigger)

21st April 2012

CALL FOR PAPERS

Dear researcher,

INVITATION TO PUBLISH ARTICLE IN *STUDENT LEARNING QUARTERLY* (SLQ)

On behalf of the editorial board, I would like to invite you to publish your research report in our upcoming Student Learning Quarterly (SLQ) (SSN: 2224-946X), Volume 2, Issue 4, (May, 2012). SLQ is open access, interdisciplinary on-line journal which is quarterly publishes and invite research papers, reports, scholarly articles and case studies in interdisciplinary areas. SLQ is published quarterly in February, May, August and November.

SLQ (SSN: 2224-946X) is indexed in UlrichWeb (Global Serial Directory), EBSCO, Cabell's Directories, ProQuest, Academic Resources (ourGlocal.com), JournalSeek, Electronic Journals and Newsletters (Open New Jour), World's biggest open access English language journals portal (Open J-Gate), , getCITED, Google Scholar, and Research Gate.

To standardize the format, we would recommend the article to be written using the following style and format:

Manuscripts submitted to *SLQ* should follow the style prescribed by the sixth edition of the Publication Manual of the American Psychological Association (American Psychological Association, 2009), including a page number and an identifying phrase (running head) as per APA style. However, the following exceptions to APA style are to be observed:

Page Formatting. Manuscripts should be **single-spaced** (including quotations, footnotes, and references), with primary manuscript text set to 12 point Times New Roman or equivalent. Manuscript pages should be formatted for North American standard 8.5 × 11 paper or ISO standard A4, with margins of 2.5cm (1 inch) or greater.

SLQ generally will not accept manuscripts which exceed the length guidelines (20 single spaced pages, including references). Authors who desire to submit longer manuscripts must include a cover letter detailing how the manuscript describes groundbreaking research that can only be properly presented in a longer format.

***Abstract Length*.** Abstracts are limited to 300 words.

***Abstract Keywords*.** Immediately following the abstract, please include search keywords for your manuscript in the following format:

Keywords: assessment, early childhood, chemistry

***Reference style*.** References should follow the APA style.

Lederman, N.G., & O'Malley, M. (1990). Students' perceptions of tentativeness in science: Development, use, and sources of change. *Science Education*, 74, 225-239.

File Format. The manuscript should be prepared for submission in Microsoft Word document (.doc **not** .docx) or Adobe Acrobat (.pdf) format.

***Appendixes*.** The Journal strongly discourages the use of print appendixes. Please submit anything that would belong in a traditional appendix as supplementary material.

We would much appreciate your effort and contributions.

Thank you

……

José Satsumi López- Morales

General Secratary,
Human Resource Management Academic Research Society
Macro think Institute, Virginia, US.
Email: jose@mt.edu
Phone: +45 5030 1858

6. Problem Scenario (PBL Student Task)

Student Task

You are a team of researchers planning to conduct a review on the research about students´ alternative conceptions. Examples of findings from research on concepts related to the properties of light are attached. Your research team has decided to publish the review in the form of a research report in a journal. Refer to the invitation letter and write a research report on a chosen topic in science.

8. Alternative Assessment (Rubric to Evaluate Article)

Elements	**Advanced** **(4 points)**	**Effective/Developing** **(3 points)**	**Less effective/ Introductory** **(2 points)**	**Poor** **(1 point)**	**Point** **obtained**
Title page	Title includes variables and some articulation of relations. All relevant parts of the title page are included. APA style is completely correct	All relevant parts of the title page are included. Title is appropriate but may not be very concise.	Title does not effectively convey all the variables in the study. Some needed elements may be missing.	Title is not appropriate for a scientific paper. Title page does not follow APA style.	
Abstract	Abstract includes research purpose, variables, methodology, major results, and implications/limitations of those results stated clearly and concisely within the word limit.	Abstract includes all essential information but is misleading due to a lack of concise sentence structure, or there may be some information missing.	Abstract is missing essential information from two paper sections (e.g: no methodology, no purpose) or is significantly over the word limit.	Abstract has some incorrect information or does not accurately portray the works. Three or more important elements are missing.	
Introduction/Body **-Topic and context**	Paper (i.e., first paragraph or two) begins in a broad manner, clearly explains the problem to be investigated provides theoretical and real-world context for the main concept in the study. An explanation of the key concept is provided. Appropriate topic in level and in content.	Paper starts somewhat broadly, and provides some theoretical or real-world context for the main concept in the study. An explanation of the key concept or question is provided, but it could be clearer. The topic is appropriate but not necessarily novel in the field.	More clarity in the opening may be needed or the paper may begin with a definition of the topic but provide very little context for the idea (e.g., may begin immediately with review of previous research).	Paper focuses immediately on the method, or no context for the topic is provided. The topic is not appropriate or is overly simplistic	

Introduction/Body **-Structure and flow**	There is a clear organization to the paper, and transitions are smooth and effective. Tone is appropriately formal. Topic sentences are appropriate for paragraphs, and key ideas are explained/ described as needed. Punctuation and grammar are almost completely correct, including proper tenses and voice.	Organization is effective although improvements could be made. Transitions are generally there, but are occasionally not smooth, and paragraphs may stray from the central idea. Tone is appropriately formal. Punctuation and grammar are almost completely correct.	Organization is less adequate, making the paper difficult to follow. Transitions are sometimes there, and those that are there could be improved. Tone is occasionally colloquial. Punctuation and grammar are usually correct, but there are consistent mistakes.	Organization is confusing. Transitions are missing or are very weak. Tone is consistently too informal. Punctuation and grammar mistakes throughout the paper. Sentences are not concise and word choice is vague.	
Introduction/Body **-Factual accuracy**	The information covered factually accurate, opinions evolve from the facts and the writings used to inform	Most of information covered are factually accurate, opinions evolve from the facts and the writings mostly used to inform	Not all the information covered factually accurate, opinions somehow drives the facts (propaganda) and the writings have the incline to persuade	Most of the information covered are not factually accurate, opinions drive the facts (propaganda) and the writings mostly used to persuade rather than to inform	
Method	Searching procedure for the articles is appropriate and detail. It is described, in order, with enough detail that a reader could replicate the study; instructions and protocol are included. Condition assignments are clear; randomization and counterbalancing are explained as necessary.	Searching procedure for the articles is appropriate and detail. The description is primarily complete but some minor details may be missing, or some procedural aspects could be explained more clearly.	Searching procedure for the articles is appropriate detail. The description is not in order or difficult to follow, or a few major details are absent.	Procedure is not appropriate or not detail. The description is unclear, or many major details are absent.	

Result **and Discussion**	Tables were used when appropriate, and called out in text. Discussion includes a restatement of the findings. Patterns in the data and relations among the variables are explained and conclusions do not go beyond the data. Author has considered to what extent the results are conclusive and can be generalized.	Tables were used when appropriate, and called out in text. Discussion includes a restatement of the findings, but the analysis of their meaning may be weak or not well connected to the hypothesis. Author somehow considered to what extent the results are conclusive and can be generalized.	Tables were used when appropriate, and called out in text. The restatement of the results is not clear or is misleading. Only some results are explained. Author has not considered to what extent the results are conclusive and can be generalized.	Tables were used when appropriate, and called out in text. Discussion incorrectly states the results or is a rehash of the introduction without clearly presenting the current study. Author has not considered to what extent the results are conclusive and can be generalized.	
References	Reference page includes all and only cited articles. The articles are appropriately scholarly and appropriate to the topic. Sufficient recent sources make the review current, and classic studies are included if applicable and available. Original articles/chapters were clearly read by the student.	Reference list may leave out some cited article or include one that was not cited. The articles are appropriately scholarly but may be somewhat tangential and were likely read by the student. Sources include a good mix of recent and classic, as necessary.	Some references may not be appropriate for the assignment. Key references are clearly cited from other sources and not likely read by the student. Sources do not include a good mix of recent and classic, if necessary.	Reference list is more like a bibliography of related sources. References may not be scholarly sources or otherwise not appropriate for the assignment (e.g., too many secondary sources), or they may not be current.	

Appendix O: The PBL toolkit for PBL3: 21st Century Learning

1. Lesson plan (PBL Description)

Course : Managing Learning in Sciences
(Pengurusan Pembelajaran didalam Sains)

Code : SSB6034

Week : 12 (12 May 2012)

Problem Template

Elements	**Description**
Topic	21st century science laboratory
Learning Outcomes	At the completion of PBL cycles, students (in groups and individuals) are expected to be able to: Knowledge: viii. Explain the central tenets of 21st century science laboratory concepts ix. Design a layout plan for a 21st century science laboratory concepts x. Justify the layout plan for 21st century science laboratory concepts Process and skills: i. Demonstrate good communication skills during the presentations ii. Acquire team skills through group work.
Duration of problem	1-2 weeks
Level of difficulty	Intermediate
Prior knowledge	-Laboratory management -Current issues in science education
Problem trigger	A poster of a competition in designing the 21 century school science laboratory
Student task	Information from the poster
Learning Issues	-What is the definition of 21st century science laboratory?

	-What are the characteristics of 21st century science laboratory? How is a 21st century science laboratory different from traditional science laboratory? -How does a 21st century science laboratory looks like? -What are the 21st century skills needed for the future workforce? -How to design learning that promotes 21st century skills? How should the lab be designed to promote 21st century skills and learning? -In what ways are current pedagogical practices incorporated in the design of 21st century lab?

1. Lesson plan (Pre-determine PBL thinking tool)

Fact	Idea	Learning Issues	Action plan
-What do we know? -What are the fact that can be extracted from the posters?	-What do we think? -What is possible explanation?	-What do we need to know? -Put the inquiry into question form	-What should we do? -Which resources are appropriate to approach?
-A competition opens to all Malaysian - To design a school science laboratory for 21st Century Learning -The laboratory designs that promote 21st Century Learning skills among the students -The design of the laboratory will be the future references -Good token of prize -Submit the layout of the floor plan	-The design of the laboratory should be comply with the 21st Century Learning -Traditional laboratory could be a good starting point to draft for the 21st Century Laboratory -To get inspirations from the high tech laboratory -The 21st Century skills should be the top priority	-What is the definition of 21st century science laboratory? -What are the characteristics of 21st century science laboratory? -How is a 21st century science laboratory different from traditional science laboratory? -How does a 21st century science laboratory looks like? -What are the 21st century skills needed for the future workforce? - How to design learning that promotes 21st century skills? -How should the lab be designed to promote 21st century skills and learning? -In what ways are current pedagogical practices incorporated in the design of 21st century lab?	Resources : Books, internet search and journal -Example of preliminary resources?? Group product: Report, presentation, rubric Task division: -Who is doing what? -How to divide the task equally among the group members?

2. Problem Scenario (PBL Student Task and PBL Trigger)

ELECTROLUX DESIGN LAB

Towards a Science Laboratory of the Future

As a part of our corporate social responsibility (CSR), we are organizing a competition to all Malaysians to contribute ideas in designing a school science laboratory for 21st century learning.

The design of the laboratory should correspond to current pedagogical practices which promote 21st century skills and learning needed for the future workforce as a point of reference in designing this future laboratory.

Applicants are requested to present their proposals to our committee and stand a chance to win the following prizes!!

WHO?
Open to all Malaysians (Individual or group)

WHEN?
Presentation of the proposal will be on 19th May 2012

WHERE?
Anggerik Room, Kuala Lumpur Convention Centre (KLCC)

First price X1 RM50 000 cash	Second price X2 RM20 000 cash	Third price X3 RM10 000 cash	2012

Please submit a layout plan of the proposed laboratory with justifications given on the features incorporated in the design.

Inquiry about the competition? please contact: lab_design@electrolux.co

The Electrolux Design Lab, Silicon Valley, California, US.

3. Alternative Assessment (Rubric to evaluate presentation)

TRAIT	Explanation of traits and score distribution			Score obtained
i. NONVERBAL SKILLS				
Eye contact	Hold attention of entire audience with the use of direct eye contact, seldom looking at notes	Consistent use of direct eye contact with audience, but still returns to notes	Display minimal or no eye contact with audience, while read mostly from the notes	
Score	5 or 4	3 or 2	1 or 0	
Body language and poise	Movements seem fluid and help the audience visualize. Student displays relaxed, self-confident nature about self, with no mistakes	Made movements or gestures that enhance articulation. Makes minor mistakes, but quickly recover from them, displays little or no tension	Very little movements or descriptive gestures. Displays some degree of tension and nervousness, has trouble recovering from mistakes	
Score	5 or 4	3 or 2	1 or 0	
ii. VERBAL SKILLS				
Enthusiasm	Demonstrates a strong, positive feeling about the topic during entire presentation	Occasionally shows positive feeling about the topic	Shows some negativity and no interest toward topic presented	
Score	5 or 4	3 or 2	1 or 0	
Elocution	Voice is clear and correct, precise pronunciation of terms	Voice is clear and pronounces most terms correctly. Most audience can hear presentation	Voice is low, incorrectly pronounce terms, and speaks too quietly for a majority of students to hear	
Score	5 or 4	3 or 2	1 or 0	

iii. CONTENT				
Subject knowledge	Demonstrates full knowledge by answering questions, with explanation and elaboration	At ease with expected answers, with limited explanation	Does not have grasp of information, able to answer only rudimentary questions	
Score	5 or 4	3 or 2	1 or 0	
Organization	Present information in logical, interesting sequences with audience can follow	Present information in logical sequences which audience can follow	Information is not delivered in sequences and logical way.	
Score	5 or 4	3 or 2	1 or 0	
21st century key elements	Consist of definition, learning, characteristics, differences, skills and justification	Missing one or two elements	Missing two or three elements	
Score	5 or 4	3 or 2	1 or 0	
Justification	Convincing, strong and relevant	Not convincing enough but still relevant	Not convince and irrelevant	
Score	5 or 4	3 or 2	1 or 0	
Mechanics	Presentations has no misspellings or grammatical errors, layout is clear and easy to follow	Presentations has no more than three misspellings or grammatical errors, layout of most page is easy to follow	Presentations has more than three misspellings or grammatical errors, layout is confusing or inappropriate	
Score	5 or 4	3 or 2	1 or 0	

Appendix P: Student Guide to PBL

Faculty of Science and Mathematics

Student Guide to Problem Based Learning (PBL) for

Managing Learning in Science (SSB6034)

Student-centred, self-directed, authentic problems, performance-based assessment, learning process and learning outcome, constructivism…

Semester 2
2011/2012

What is Problem Based Learning (PBL)?

PBL sees a shift in educational focus from a teacher-centred approach to teaching and learning to a STUDENT-CENTRED one, where students construct meaning for themselves by relating new concepts and ideas to previous knowledge. It is an alternative approach to teaching and learning, which encourages ACTIVE INVOLVEMENT of the learner (Tan, 2004). As a learner-centred method that challenges the learner to take a progressively increasing responsibility for his or her own learning PBL is therefore consistent with the CONSTRUCTIVIST theory (Coombs and Elden, 2004).

Aims of PBL implementation in the course

Different universities use PBL in different ways. Here in UPSI, we are using it to

i. help you develop your own learning strategies
ii. help you develop into independent, and self-regulating learners
iii. to inculcate skills and competences deemed important for teachers to possess like communicative, collaborative, problem solving and generic skills.

Why it is PBL?

Every intention in learning strategies should be corroborated with argument or justification, so does as the adapting PBL in this course. The rationale for implementing PBL is:

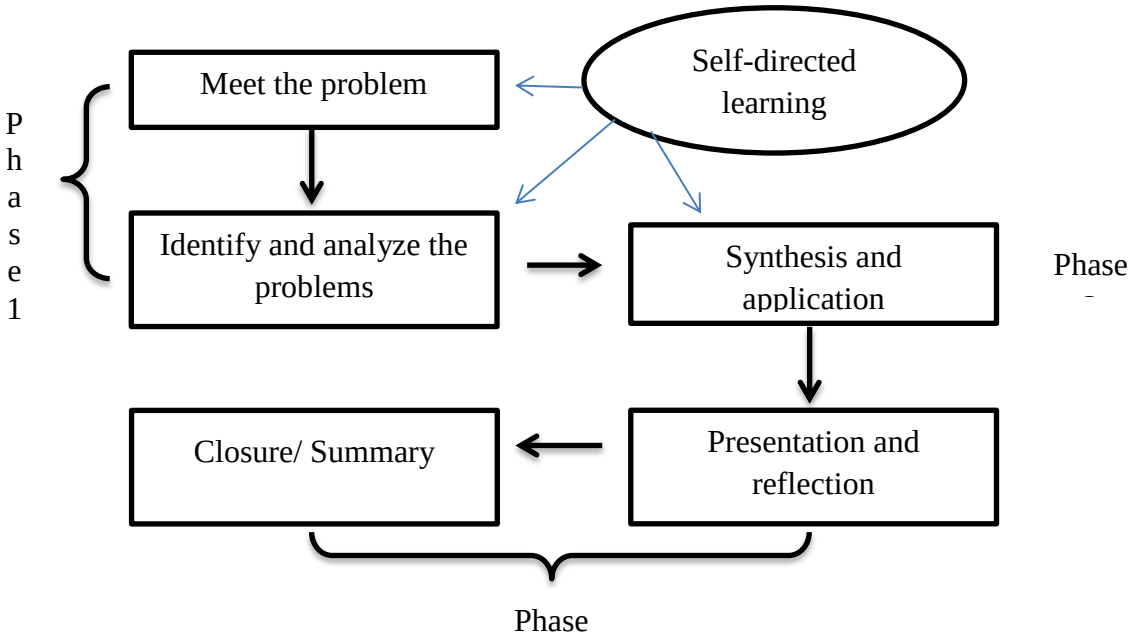
i. **i. National Higher Education Action Plan (2007-2010)**
Curricular must equip university graduates with appropriate skills to enable them to compete in an ever-changing market

ii. **Malaysia Quality Agency (MQA) initiated Outcome-Based Education (OBE) in 2007**
Students should be able to: write and complete project, analyse case studies, show their abilities to think, question, analyse and synthesize problems, research, and make decisions based on the findings.

iii. **Malaysian Teacher Standard (MTS)**
-All teachers are required to have three valued aspects of practices namely teaching professionalism; knowledge; and high teaching and learning skills.
-To achieved the desired target, need to have quality in teacher preparation progamme, including innovative teaching and emphasize on student learning rather than teaching.

How a PBL learning environment looks like?

Ill-structured and realistic problems as the starting point of class/learning to contextualize the course content. No initial lectures will be given but you are guided to approach and engage the problems, and applying your prior knowledge to given problem through PBL cycle. This is how a typical PBL cycle looks like:



Phase 1	Phase 2	Phase 3
Problem restatement and identification	Peer teaching, synthesis of information, and solution formulation	Generalization, closure and reflection

PBL Cycle (adopted from Mohd Yusof et al., 2011)

PBL thinking tool

The PBL thinking tool chart are used as an information-management tool to unravel the problem scenario/case

Fact	Ideas	Learning need	Action
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	-Possible causes/effects/ ideas/solution based on the fact identified -consider to use own experience and previous knowledge	-Phrased 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 those question -Possible resources to consult to answer the questions

Adapted from Dean (2001), pg 11.

PBL tutorial process- How it should goes?

STEP 1 **CLARIFY**	**Clarify the setting**
	-Identify unfamiliar terms, words and notions -Scribe lists those that remain unexplained after discussion
STEP 2 **DEFINE**	**Problem definition**
	-Define problems and sub-problems -Different views from group members should be considered, and record a list of agreed problems
STEP 3 **BRAINSTORM**	**Brainstorm problems**
	-Suggest possible explanation of the problems on basis of prior knowledge -Draw on each other's knowledge and identify areas of incomplete knowledge, records all discussion
STEP 4 **ANALYSE**	**Analyse Step 2 and Step 3**
	-Arrange(restructure) into tentative solutions -Throw irrelevant point away Get the systematic overview of the problems
STEP 5 **FORMULATE**	**Formulate learning goals and objectives**
	-Group reaches consensus on the learning objectives -What need to learn, where can you obtained further information -Divide the task among group members
STEP 6 **PRIVATE**	**Individual study**
	-Each group members gather information related to the objective
STEP 7 **SHARE**	**Report back to group**
	- Each group member shares results of private study

How can you work effectively in your group?

Each group should discuss and agree to a set of ground rules for the groups to function well and efficient and consider the consequences to group members who do not follow them. Here are some guidelines and your group may change or add to it:

Come on time to every class session

Taking turn as chairperson and scribe

Be prepared to discuss the assignment

Record group meeting using logs (see Appendix A). Use this log to on reflect how your group

Appoint scribe and chairperson for the each discussion. The role of the clerk and chairman should be rotated in every meeting.

Say whatever is on your mind, there is no such thing as stupid remarks

Participate as equally as possible, or at least according to individual strengths.

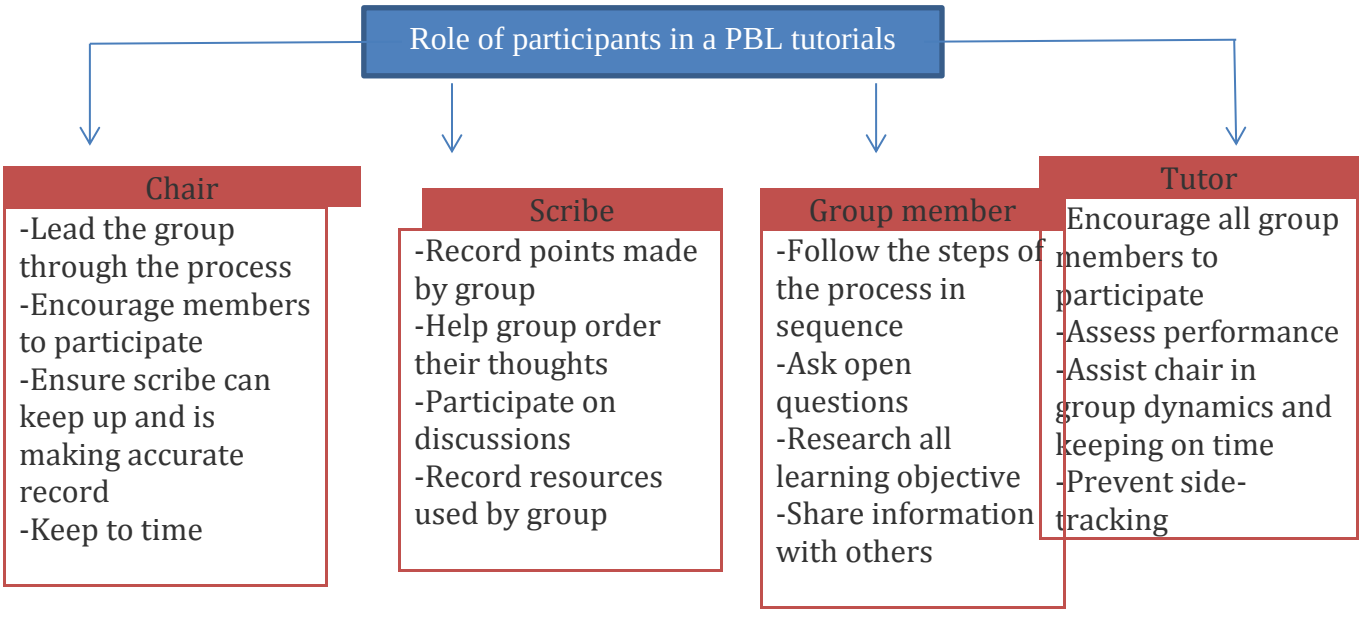
No student should dominate group discussions.

Every student should be aware of all tasks undertaken by group members and be prepared to provide constructive criticism.

Express your opinion if they differ from consensus

Silence implies acquiescence

Solicit, value and respect the opinions of all group members.



Example of problem scenario

Try it out!!
Fill in the PBL thinking tool by extracting the information from the problem scenario

Andy bought a loaf of bread from his neighbourhood bakery, Yummy Bakes, but upon reaching home, discovered small dark green specks of mould on it. He goes back to Yummy to get a refund, but Yummy refuses, insisting the bread was freshly made. Andy is now wondering what has caused the mould to grow, and what he can do about the situation.

Fact	Issues	Learning need	Action
-What do we know? -What fact that can be extracted from the problem scenario?	-What do we think? -What is possible explanation?	-What do we need to know? -Put your inquiry into question form	-What should we do? -Which resources is appropriate to approach?

Extracted from http://www.tp.edu.sg/pbl_resources_problem_scenarios.htm

Appendix Q: Field-note observations (Week 4)

Report on Week 4 (Description of the first problem, field note for observation)

Course	Managing Science Learning
Date and Time	17th March 2012 (11-2 pm)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	30 (6 Groups)

Today is going to be the first PBL class. For the first time, I´m planning to discuss with the students the *Student Guide to PBL* handouts before they embark on PBL learning process. Though some of them are already experience PBL, majority of them are still new to PBL. Therefore, it is important to introduce them to PBL.

Time	Observation
11.00-11.20am	• The first 20minutes of the class is allocate to brief the students about PBL learning process and learning environment. To make the briefing sessions more explicit, I gave students the *Student Guide to PBL*. • I want students to know what the PBL is all about so that they could see the rationale of why the course is adapting PBL as teaching and learning strategies. The guide consist of introduction to PBL, characteristics of PBL, rationale for learning through PBL, depiction of PBL processes, proposed steps to approach the problems, expectations on the learners and a walk through a sample scenario as an introduction to the PBL process. We discussed the course expectation and guideline as a large group. I told students I expected them to work independently and in teams to deal with the problem posed to them. • This was necessary as we should not assume that the learners are naturally skilled in group collaborations and handling PBL scenarios of open ended problems. Furthermore, students who are experiencing

	PBL for the first time need scaffolding as they develop problem-solving strategies.
11.20-12.20pm	• Last part of the *Guide* consist of a sample problem scenario and students in group were asked to fill in the PBL thinking tools. Group discussion help students to elaborate on their own knowledge. The confrontation with the problems to be understood and with other students knowledge of what might explain the phenomena will lead to enrichment of the students cognitive structure. • I give each group 20minutes to complete the PBL thinking tool that comprises 4 columns: *Facts, Ideas, Learning Issues* and *Action Plan*. I go around to each group to get more insights on how students fill in the thinking tool for the first time. It seems easy for all group to fill out the *Facts* and the *Ideas* column. As for class objective, I asked them to come out with their own *Learning Issues*, what are the questions that they have in the scenario and what resources that they would like to approach. • It is not necessary that one idea will lead to one learning issue. In the same manner, one idea could be expand to more than one learning need. Similarly, 2 ideas could be merge into single learning need.
12.20-1.10pm	• Showing the videotaped to the class. The video serve as a trigger initiates the learning that centred around a videotaped in a public elementary school classroom. The 15minutes duration video showed a teacher introduce to her pupils about the body part . This video is relevant to their profession and make them to think and reflect whether their own teaching is adapting constructivism principles. • Students might have different conception of what could be considered as good teaching practices.However in this PBL tasks, I want them to evaluate the teachers on constructivism perspectives. I would like to know to which extend they think the teacher adopt constructivism principles in

	her teachings, and what are the appropriate tools to evaluate her teachings. While watching the videos, students record their observation that could be evidence for constructivism. • Before students start their group discussions, I give simple explanation to students about the videotaped. After that, I asked them to appoint the scriber and the chairperson for the discussions. I asked them to come out with learning issues, what are the questions or inquiries that they might have, and what kind of resources that they want to approach. • To some extend, I give the ownerships of learning to students by do not specify which resources that they should approach to deal with the first problem scenario, but I did mentioned about variety form of resources they can bring in the next class like ministry reports on student-centred learning, journal articles, books and education-based NGO reports.
1.10-2.00pm	• Group discussion and brainstorming -I went to each group to get their initial ideas about the application of the constructivism in the classroom. I Asked them (open-ended Qs) -What are the principles of constructivist T&L? -In what ways singing session approach could be considered as constructivist approach? -How to create a classroom environment (consider role of teacher, student, facilities, settings) that fulfill constructivist T&L approach? • I also asked them more specific questions -What type of instruments can be use? -What would be the best form of instruments to evaluate a constructivist teachings? -What are the component to be involved in developing the instrument for assessing lessons?

	• call upon a group to present what they have discusses. A representative from that group present their FILA chart (Fact, Idea, Learning Issues and Action Plan) • It is not likely that group of students will completed thier PBL tasks on the first week, and their individual studies and feedback from the facilitators motivates the next round of group work. During the last few minutes, students summarized their progress and planned what to do next.

Appendix Q: Field-note observations (Week 5)

Observation for Week 5 (24th March 2012)

Course	Managing Science Learning
Date and Time	24th March 2012 (11-2 pm) (Week 5)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	27

In todays´ class, I was informed by the class leader that there are 2 students drop off from the course and 6 students are absence. Therefore, there are only 27 students in the class. This is the second week of PBL after students were exposed to the PBL problem (PBL1) last week. My plan for today´s class to further facilitate group of students to come out with their own learning issues from the PBL scenario.

Time	Observation/ Events
11.20- 12.10pm	• I allocated this time frame to comments on their thinking tools. Evaluating the PBL thinking tools filled by the students, most of the groups would like to evaluate the personality of the teachers, not the constructivism principles behind her lessons. • The evaluation tools that they have to develop should have the ability to tell to what extend the teachers in the video adapt constructivism principles in her lessons. Therefore, to do this, group of students have to come out with evaluation tools (be it rubrics, checklist or etc) to report on the constructivism elements in her lessons.
12.10- 12.40pm	• Group discussions to address and reflect on my comments. During this period, I asked students to come out with the learning issues from the resources that they already consulted. Students start the discussions by telling each other their learning issues on problem scenario. • Students reach consensus by discussing on the similarities, differences and which point is not relevant. I expect them to present the problem solution in today´s classrooms. But student feels that they do not have sufficient time. They can finished the problem solutions, but the quality is questionable.
12.40- 1.00pm	• I showed them again the trigger on the form of a video showing a primary school teacher teaching her pupils about human body parts. I showed them again the video based on their request. They would like to determine whether their

	instruments is suitable and according to the constructivist principles.
1.00- 2.00pm	• Do the discussions to reach final decisions... I go around to each group and facilitate and pose them some questions to trigger the discussions in the groups. While looking at their thinking tools, I would say most of the groups should be more specifics. • I go around and asked each groups what kind of evaluation tools that they would like to develop in order to assess the constructivist elements in the teachings. There are several types of evaluation tools that they want to develop: 1. Charles group: Rubric 2. Faizah group: Rubric 3. Izzat group: Rubric 4. Masodiah group: Not decided yet 5. Saidatulnoor group: Rubric 6. Saraspathy group: Checklist and rubric 7. Sharifah group: Checklist and rubrics 8. Alia Group: Resources are there, but still undecided about the evaluation tools. • Therefore, from all the eight groups, 4 chose the Rubric as the evaluation tools to evaluate. Of course, there are several groups asking me whether it is appropriate to chose specific evaluation tools to assess the constructivism teaching and learning. Rubrics and checklists are both suitable to assess a constructivism teachings, however it should be properly develop to reflect the real constructivism principles in a primary classrooms. • Due to time constraints, 3 groups (Izzat ,Sharifah and Faizah) will present their discussions next week. • Since students could not finished their tasks as what I expected, I came out with today´s class objective. Students should come out with the learning issues among group members, how they are going to do the presentations, tasks division among the group members, and how do they collaborate although they could not meet beyond the class time.

	• Half an hour before the class dismissed, each group present their plan for the the next week´s presentations, how do they divide the tasks and when do they want to merge the information. All groups come out with common learning issues that they want to research on, particularly in: -Theory, concept and principles of constructivist -Example of constructivist strategies -Different between constructivist and non-constructivist.

Appendix Q: Field-note observations (Week 6)

Observation for Week 6

Course	Managing Science Learning
Date and Time	31st March 2012 (11-2 pm) (Week 6)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	25

Today´s class is devoted for students´ presentation on the problem scenario introduce to them last two weeks (a videotaped showing a teacher teaching primary school pupils on *body part* topic). It is expected that three (3) group will present their solutions for today´s class. I didn´t tell the students which three groups have to present in today´s class, so that all group will prepared.

As for the last week discussions, the whole class comes out with common learning issues. Each group will have to present on the following issues during their presentations:

1. What are the principles of constructivist teaching and learning?
2. How the component of teaching plan of the teacher can be related to constructivist concept
3. How to create a classroom environment (role of teacher, students, facilities, and classroom settings) that flfil constructivist principles?
4. What types of instruments/evaluation tools can be used to assess a lesson based on constructivist principles?
5. What would be the most feasible evaluation tool to assess a lesson based on constructivist principles?
6. What are the component to be included in developing the instruments for assessing the lessons?

Time	Observation/ Events
11.15-11.30am	• Before first group presenting their works, I explained to students about the rubric that I will use to assess their performance during presentations. It is vital to tell students our expectation, so that they will try to address all the tenets in the rubric. The rubric takes the holistic approach of presentation evaluation comprising 4 main traits to evaluate:

	i. Verbal skills ii. Non-verbal skills iii. Content coverage iv. Mechanics
11.30-12.00pm	To ensure that students are on track in doing the presentation, Sopia succinctly ask each group about their progression and what they had done so far. As mentioned above, there are 6 learning issues group of students need to work with. However, we found that only one group (Izzat Group) answer all the 6 learning issues, for the rest of the group (6 groups), they only completed the evaluation tools (either rubric or checklist) and suggestions to improve the teaching and learning sessions to be more constructivist.
12.00-12.30pm	• Since there is only one group completed the task, me and Sopia decided to allowed only this group to do the presentations. For the rest of the group, we asked them to answer all the learning issues before they can do the presentations. When I go to each of these groups, the information to answer the learning issues is there, but they do not put it up in their powerpoint slides. • Izzat group now started off the presentations by discussing about the principle of constructivist. According to this group, there 9 principles of constructivist. After that, they present about the learning environment in in constructivist class. For evaluation tools, this group was using the rubric and checklist. Last part of the presentation was about their suggestions on how teacher in the video clip could improvise her lesson to be more constructivist and student-centred. Overall, the presentation are fine and students are able to achieve the learning outcome. Since there is 4 members in the group, each members presented their respective parts. They used both English and Malay language as medium of presentations. • My comments for their presentation is on their rubric to evaluate a lesson based on constructivist principles. Some terms used in the rubric is vague and very abstract. Example of the vague term is like ´some´, ´very good´ and ´not observe`. These terms could not give a specific explanation of what is actually happening in a class. I asked them to be more specific and using words that somehow can show the quantity of traits observed. • While students presenting their works, I used the rubric to evaluate their performance during presentations.
12.30pm-12.45pm	• We conclude todays´ lesson by reminding them to work on their learning issues that they left out unintentionally. All groups are slated to present in the next week class. Class was dismiss earlier than what it is suppose as Sopia have to go to another town at 1pm.

Appendix Q: Field-note observations (Week 9)

Observation for Week 9 (21st April 2012)

Course	Managing Science Learning
Date and Time	21st April 2012 (11-2 pm) (Week 9)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	30

In todays´ class, I would like to present to the students second problem scenario, the Alternative Conception in Science Learning

Time	Observation/ Events
11.20-11.50am	• First, give the trigger of collective empirical findings of concepts related to the property of lights. This is to stimulate, activate and elicit students´ prior knowledge on alternative conceptions. • In the handout, there are variety of alternative conception happened among the pupils • In the same group they work before, I asked them to discuss the findings. I gave them 10 minutes to discuss in their own group.
11.50-12.10pm	• I walked around the room and sat in on each group. For each group, I allocate 5-7minutes to monitor their thinking, probing questions, and provide some guidance. Some groups are eagerly waiting for me to come to their groups, while some groups merely asking me some additional questions to verify their current progress before proceeding to the next steps. This shows unequal progressions among the PBL groups
12.10-12.40pm	• The learning issues identified serve to guide students in their individual studies. Following theperiod of individual studies, the students reconvene to share their findings and discuss with the group members and eventually co-constructed their shared understandings of the issues presented in the problems.
12.40-1.00pm	• While the group brainstorming the possible cause of alternative conceptions, each group will have to discuss, review and investigate the definition, role of teachers, possible cause and effects and etc. This is when much learning occurs, as students help to each other understand the alternative conceptions.

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I circulate among the groups, providing facilitation and guidance but not the solutions. There are several groups well explored avenues unanticipated by the facilitators. This is highly desirable and should be couraged.
I try to avoid as much as possible in controlling the agenda of the groups.
I stopped the small group discussions and briefly discuss the ideas with the entire class. I believe that this is the way to value every group contributions and to give them the opportunity to learn from other groups.

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<tr><td>1.00-
2.00pm</td><td>

Before the class dismissed, I asked each of the group to submit to me on how do they divide the tasks along with the deadline. It is important to make things explicit since it is not easy for them to meet beyond the class time. Here is the ways how students divide the task among them:

<table>
<tr><td colspan="2">Group: Vimalah</td></tr>
<tr><td colspan="2">Chosen topic: Human Digestive System</td></tr>
<tr><td>Tasks</td><td>Responsibility</td></tr>
<tr><td>i. Finding journal (4 journal per person)</td><td>All</td></tr>
<tr><td>ii. Ensure the selected journals do not overlap with other members</td><td>Vimalah</td></tr>
<tr><td>iii. Review journal</td><td>All</td></tr>
<tr><td>iv. Compile the work</td><td>Saraspathy</td></tr>
<tr><td>v. Introduction</td><td>Chai</td></tr>
<tr><td>vi. Implication</td><td>Vimalah</td></tr>
<tr><td>vii. Conclusion</td><td>Jagatheswari</td></tr>
<tr><td>viii. Format (editing)</td><td>Chai</td></tr>
<tr><td>x. Abstract</td><td>Jagatheswari</td></tr>
</table>
<table>
<tr><td colspan="2">Group: Gunalan</td></tr>
<tr><td colspan="2">Group due date: 22nd April 2013</td></tr>
<tr><td>Tasks</td><td>Responsibility</td></tr>
</table>
</td></tr>
</table>

i. Finding journal (Minimum 3 journal per person)	All
ii. Ensure the selected journals do not overlap with other members	Vimala
iii. Compile the work	Charles
iv. Introduction (Abstract)	Guna
v. Implication	Malar
vi. Conclusion	Vimalah
vii. Format (editing)	Guna

Group: 5 voices	
Tasks	Responsibility
i. Abstract	All
ii. General introduction on alternative conception -What is the alternative conception in science? -What are the causes of alternative conception	Hana
iii. Learning issues (PBL thinking tool)	Adnin, Nina, Siti and Ainoor
iv. References	All
v. APA	All
vi. Conclusion	All

Group: Allia
Chosen topic: Photosynthesis
Deadline: Submit on Thursday

Name		Task
i. Nurul Allia	to search on	-In what ways that alternative conception affect learning? -What are other terms similar to alternative conception?
ii. Nurul Nadhirah		-How to overcome alternative conception among the students? -What is the common alternative conception?
iii. Nurul Suhaidah		-How to elicit alternative conception? -How to reconcile alternative conception?
iv. Siti Fauzanah		-What is alternative conception? -What are the causes of alternative conception?

Group: Arasumani	
Chosen topic: Misconceptions in Mammal topic	
i.	Learning issues-Divided among the group members via email
ii.	New information (literature review) submit to each of the group members on Tuesday
iii.	Group discussion and draft on journal article on Friday
iv.	Send the draft to Dr Sopia or Mr.Termizi on Saturday
v.	I will email the learning issues according to the group members name

Group: Izzat	
Chosen topic: Ecological or Phase Changes in Water	
Tasks	Responsibility
i. Outline of the research report	Ruzaidi
ii. Review journal #2 and #3	Izzat
iii. Review journal #2	Wan
iv. Review journal #3	Norman
v. Abstract	Izzat
vi. Introduction	Ruzaidi
vii. Literature review	Norman
viii. Implication, suggestion and conclusion	Wan
x. References	Norman
xi. Appendix	Wan

Group: Sharifah		
Deadline: 24th April 2012		
Chosen topic: Density		
Elements	Name	Deadline
i. Abstract	Shatirah	26th April 2012
ii. Introduction	Norhazila	23rd April 2012 (Monday)
iii. Learning issues 1. What is the alternative conception in science? 2. What are the causes of alternative conception? 3. How to overcome the AC	Norhazila	25th April 2012 (Wednesday)

	among students? 4. How to reconcile the AC? 5. How to elicit the AC? 6. In what ways the AC affect learning? 7. What are the other terms used to describe AC? 8. What is the common AC in science learning? 9. What are the format of writing research report?	Noor Azlina Noor Azlina Shatirah Norlida	
iv.	Discussion	Sharifah	26th April 2012
v.	Conclusion	Sharifah	26th April 2012
vi.	References	All	26th April 2012

Appendix Q: Field-note observations (Week 10)

Observation for Week 10 (28th April 2012)

Course	Managing Science Learning
Date and Time	28th April 2012 (11-2 pm) (Week 10)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	28

Today´s class is devoted for students to further discuss about their writings in the form of review paper in alternative conceptions. While you were here last week (21st April 2012, Week 9), I gave them the problem scenario and all the learning materials. They already divided the task among the group members during that time. So in this week, they will compile their work from the individual studies and discuss on how to write a review paper.

Time	Observation/ Events
11.20-11.40am	• Class is only starts at 11.20am since I´m waiting for all of them to be in the class. Most of the students have a class in earlier hours. I started the class by asking them generally what they are doing during their individual studies. Most of them said they were searching for relevant journal articles to be reviewed and using general search engine like google chrome and yahoo to do the searching. Each of the group were already have the preliminary draft for their article. But there is no content yet. • Since this is their first experience in writing the journal article, I showed and explain to them several examples of journal articles and review papers. I emphasize my explanation on the typical format of an academic paper and the content for each of the outline. The typical format in writing the abstract is a short introduction, the purpose or the relevant of the writings, methodology in conducting the research, general findings and conclusion and implications. Then, I proceed my explanation on the body part of the article, starting with the introduction. *Introduction* Since they are going to write a review paper in alternative conception, I´m suggesting to them to write some general explanations about alternative conception, and converge the writing into the alternative conceptions of their own chosen topic. *Methodology* Since this is a review paper, I explains that the journal articles is the raw data. They should

	explains how they search for the relevant journal articles to be reviewed, what keywords they were used to trace this journal articles, and what criteria do they set to choose the relevant articles. *Findings* Findings in a review articles is reported from the findings of articles reviewed. *Discussions* In this part, I gave quite a lot of examples since this is among the difficult parts in writings an article. I asked them to justify and make arguments of their findings, and these should be supported from the previous research as well. • After discussing all of these , I asked whether the students have questions or inquiry. There is no questions from students. Then I asked them to starts their group discussions.
11.40-1.30pm	This is the discussion periods for the students. I play my role as the floating facilitator, by going to each group and assist them to achieve the learning goals. In my plan before entering the class, I will devoted for only 1 hour for students to do the discussions. However, there is a lot of questions and inquiry to me from each of the group. So I need to extend the discussions time until 1.30pm so that the students will have clear understanding what they should do and how to deals with the task given. While approaching each group, I asked several questions and write it on my notebook. Here is some information I got from each group: • Group 1: Review of the alternative conception in Photosynthesis topic. All in all, there 16 journal articles they want to reviewed. However, they are not sure whether all of the articles is related to their review task. They want to read it first to determine its relevancy. In today´s discussions, they want to focus on results and discussions part. • Group 2: Review of the alternative conception in Density topic. There are two journal articles focused on alternative conceptions in density topic, and the rest of the articles, which is more than 10 articles they found, discussing about the general tenets of alternative conceptions. The content for their writings is there, all they want to do today is to arrange them in an article forms. • Group 3: Review of the alternative conception in Osmosis and Diffusion topic. This group already have 6 research findings of alternative conceptions in osmosis and diffusion, extracted

	from 6 journal articles. There are another 4 journal articles need to read. They already have the outline or format for their article review, but they do want to finalize the findings first, before proceeding with the format. For Introduction part, they want to generally define the alternative conception and divided the Discussions into 3 part s. • Group 4: Review of the alternative conception in Sound topic. This group already have their outline for the review paper, and research findings from their readings. They could find 4 to 5 articles discussing about alternative misconceptions in sound and 10 articles reporting on general tenets of alternative conceptions. To search for the journal articles, they are using ´alternative conception in sounds´and ´misconceptions in sounds´as the keywords. • Group 5: Review of the alternative conception in Heat and Temperature topic. What they are doing when I asked them is to summarize the journals. But they will find some more journals because they feel its not enough to have only these articles. There are 4 members in this group. 3 will summarize the articles, while another one members will find some more relevant journals. The outline for their review paper is there, but it is not yet finalize since they are still not finished to read all the articles. • Group 6: Review of the alternative conception in Digestive System topic. Already have the content for introduction part, which is definition and the important to address alternative conceptions. They also want to find another articles as they do not feel suffice with the articles they have. They were targeted to get at least 4 articles. • Group 7: Review of the alternative conception in Animal topic. The group is now started to write the content for the introduction. They are now have enough articles and will scrutinize each of them to get the point in writing their review article.
1.00pm	• I started to give a reflection sheet to each of the group. Each group should submit this reflection before the class is dismiss. First part of the reflection requires students to discuss with group members since it is all about their group process . The second part asking about their self directed learning during the individual study for 1 week. Here is the question of the reflection: 1. Reflection on last week´s group discussions i. Briefly explain how your group starts the discussions? ii. Is there any strategy adopted to enhanced group discussions? iii. What is your suggestion to make your group discussion more efficient and effective?

	iv. Reflection on self-directed learning (individual study) For each of the group members, answers the following questions i- Describe the task given to you ii- What resources do you approach to deal with the task? iii- Do you have any problems to find the resources? iv- Do you have any prior preparation for todays´ discussions
1.30pm-2.00pm	I finished to facilitate students in their respective groups. Before the class dismiss, I used this last half an hour for each group to briefly present the outline or the format of their review articles and what they are planning to do. Most of the groups now have an outline for the article, and have some preliminary content for each outline.

The deliverables for this task is the group research report in the form of review articles. They are supposed to submit their review articles in the Week 11 (5th of May), however since there is no class for this week due to the public holiday, they will submit to me the review articles by this week (Week 12, 12th of May). To evaluate their review articles, I´m using a rubric .

Appendix Q: Field-note observations (Week 12)

Observation for Week 12 (12th May 2012)

Course	Managing Science Learning
Date and Time	12th May 2012 (11-2 pm) (Week 12)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	26 (7 Groups) (7 students were absent)

For today´s class, I introduced to students the third PBL task. The purpose of today´s task is to introduce to students about the 21st century learning. I want them to understand and internalize the concept of 21st century learning and apply the knowledge to design a layout of a science laboratory that correspond to the central tenets of 21st century learning.

Group of students are expected to come out with the following learning issues to research on:

-What is the definition of 21st century science laboratory?
-What are the characteristics of 21st century science laboratory?
How is a 21st century science laboratory different from traditional science laboratory?
-How does a 21st century science laboratory looks like?
-What are the 21st century skills needed for the future workforce?
-How to design learning that promotes 21st century skills?
How should the lab be designed to promote 21st century skills and learning?
-In what ways are current pedagogical practices incorporated in the design of 21st century lab?

Time	Observation/ Events
11.20-11.55am	-Today is the last for students to submit their review articles. Before the submissions, I used the review article from a group with my comments to discuss with the whole class. I highlight about the format, the structure and the content for each part of the article. -My general comments for this piece of writing are the inability of the authors (the students) to arrange the information properly. For example, in the general definition for alternative conception paragraph, I can find some findings from their reviews. There is also inconsistency in using the terms. In most part of the writings, they are using the ´alternative conception´, but in some parts, they are using

	´misconceptions´. -Then I asked the students whether they are ready to submit their article now. But I just found the silence responds from them. It seems like they are now not ´confident´ after I explained about the comments from one of group. Realizing it, I discuss with Sopia whether it would be ok if I allowed the students to send their works in the next week. Sopia agreed, and I gave them another week for them to improvise their work.
11.55-12.10pm	Its time for Sopia to introduce the new PBL task. She distributes a poster to each of the group. The poster is about a competition organize by Electrolux Design Lab to design a 21 century science laboratory.
12.10 - 12.25pm	• After briefing by Sopia, the students started their discussions by individually read the poster. After a short while, they started the brainstorming on the poster. They are now identifying the facts that they can extracted from the poster, their thoughts about what are the possible explanation from the information gathered, and what are the inquiry they had in order to address all the issues arises from the poster.
12.25-12.55pm	• After allocate 15 minutes for students to do the discussions, Sopia started the whole class discussions. Who class discussion is important for us to ensure that each group is on the track and do not stray from the learning outcome that we set for the sessions. • Since there is 7 groups in the class, Sopia asked each group the learning issues arises from their discussions. Each group gives different learning issues and most of the learning issues posed by students are correspond to the learning issues that we set up before (see above) although we have to rephrase it to be more comprehendible. • Sopia writes all the learning issues posed by the group´s representative on a white board. This is to ensure that all students are aware what is being discuss now and they can compare with their own respective learning issues arises from their group discussions.

	• After 10minutes, students can come out with all the learning issues for today´s lesson. Sopia reiterate all the learning issues and remind the class to address all the learning issues. By that, we are now move to the new activity, the SWOT (Strength, Weaknesses, Opportunities and Threat) analysis for the traditional labs. • Since the PBL task is all about to design a floor plan for the 21st century science lab, it would be good if their design is using the traditional science lab design as a point of departure in designing the 21st century science lab. SWOT analysis will helps students to contemplate how the traditional labs could be the affordance, barriers or even drivers in designing the 21st century science labs. This also a group-based activity.
12.55-1.00pm	Sopia gives a 5 minutes break
1.00-1.20pm	This is the period for students in their group to do the SWOT analysis.
1.20-2.00pm	• We call upon a group to present their SWOT analysis. We could not afford to ask for each groups to present their SWOT analysis due to the time constraints. There are 6 Strengths and 6 Weaknesses identified by this group (please see the attachment). For every point, the group elaborate and other group commented on it. Another 4 points were added by the rest of the group, 2 points for Strength and 2 points for Weaknesses. • It almost 2pm, we remind our students to do their individual learning . We were also told them that in the next class, each group have to present the layout of their 21st century lab and providing the arguments for the layout.

Appendix Q: Field-note observations (Week 13)

Observation for Week 13 (19th May 2012)

Course	Managing Science Learning
Date and Time	19th May 2012 (11-2 pm) (Week 13)
Venue	TMB-12
Lecturer	Assoc Prof Sopia Md.Yassin/ Mohamad Termizi Borhan
No of student	28

Time	Observation/ Events
11.10-11.25am	• Class started by Sopia explaining about the rubric for presentations. We are using rubric to evaluate students presentations. It is important for us to reveal what we are assessing during their presentations so that they could meet the expectations. • Though we have the rubric for presentations during the PBL1, this rubric has a little change in the content part. Now we are assessing the content with regard to the 21st century learning skills.
11.25-11.50pm	• Allia group was the first group to presents. First part of presentations is the operational terms of 21st Century Learning that involve learning that could be occurred anywhere, and learning skills that inculcate creativity and communications. Second presenter presenting on the criteria for the 21 Century Learning laboratory that comply with the principles. The third presenter presenting on the laboratory layout. The group members justify their laboratory designs and the rationale for every decision to develop the laboratory layout. All in all, students are trying to integrate the principles of 21 Century Learning into innovative laboratory designs. • Generally this group presents well, however Sopia comments that they should not be so down-to-earth, try to use more firm words and intonations while presenting their ideas to convince the people. Majority of the members are reading the slides, therefore the eye contact with the audience is rarely happen and the slides have too much words. • From my point of view, they are a good team players since the task is divided equally and they could communicate quite well in English.

11.50 - 12.35pm	• Second presentation was from Norman group. The first presenter presenting about reinventing 21st century learning, what kind of skills that students should be equipped with. There is also a good comparison between 20th Century and 21st Century Learning. Second presenter presenting on skills that deemed important in 21st Century Learning, research findings in laboratory arrangements and how it connect to learning. At the end of the presentations, the presenter describes a table of comparisons between current school science laboratory with the 21st Century school science laboratory. • The third presenter describes about the new approach in designing the science laboratory. The presentations were proceed with how much space is needed for each students, and the space needed is increase with the increase in students. The last presenter presenting a summing up presentations dealing with their proposal on how a 21st Century Learning school science laboratory should look like. The laboratory are 1440 square feet with the characteristics of multipurpose laboratory. In addition ,the laboratory also have a space at the centre for easy movements.
12.35-1.20pm	• Third presentations were performed by Charles group. Like the first group, the first presenter presenting the definition of 21st Century Learning, and what are the facilities that are needed to support the 21st Century laboratory. He also explaining the basic features of 21st Century Learning. The presentation continues by second presenter that deal with the design and features of 21st Century laboratory in details. • Third presenter proceeds the group presentations by explaining the floor plan for the 21st Century laboratory. Last part of the presentations was conducted by the fourth presenter by comparing and contrasting the differences between current science laboratory in schools and the 21st Century laboratory.
1.20-1.40pm	• Fourth presentations were performed by Sharifah group. The first presenter presents definition of 21st Century Learning, second presenter describes a table that depicts the differences between 21st Century Learning and the current laboratory designs. Upon considering the definitions and characteristics of the 21st Century Learning, the third presenter presents their laboratory layout. • To complete the layout, the 4th presenter proposing tools and equipment in the laboratory that are important for students to deal with the experiments.

1.40-2.10pm	• Last group to present was Arasu group. This time around, the group sharing a video about the 21st Century Learning. The video comprises the basic tenets of 21st Century Learning. The second presenter presenting their laboratory layout. She explain the ideal size and the variability of the layout. • Next, the third presenter explains about variety of tool and furniture that should be in the innovative laboratory. The fourth presenter continues her peer presentations by explaining about the teaching wall, interactive board. The fifth presenter explaining about the windows, doors and ventilations.

Appendix R: Article 5: ***Impact of Problem Based Learning (PBL) Implementation on Student Learning***

Impact of Problem Based Learning (PBL) Implementation on Student Learning

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Abstract

This paper describes the implementation of Problem Based Learning (PBL) as a teaching and learning approach in a postgraduate teacher education course, namely Managing Learning in Science (SSB6034). PBL was introduced in response to the emphasis on student-centred learning in Malaysian higher education to foster skills and competences acquisition, and simultaneously serve as a platform for the authors to better understand PBL implementation in the real world practice. The discussions focus on the way PBL was designed and introduced and the learning processes involved in the groups. To investigate PBL impact students learning, we explored students' learning experiences and data were obtained from interviews, observations, and students' written reflections. A grounded theory approach was used to analyze the data, whereby themes that emerged from variety of qualitative approach of data collection were compared to identify general patterns of similarities, points of clarification and contradictions. Multiple data collection strategies and sources employed lead to a comprehensive understanding of the interacting variables. The findings suggest that students generally welcome the approach and the impact of learning in PBL were associated with knowledge and skills acquired, and the value of group learning process. Reflecting on their learning process, students thought that their group should emphasize on different roles of members, and better time and timetable management. As a new learner in PBL, students also experienced several challenges which include anxiety during the early semester, insufficient time to deal with the PBL tasks and group conflict.

Keywords: Problem based learning, teacher education, PBL design, student learning, challenges, reflection.

1. Introduction

There has been a shift in recent times on teaching and learning approaches employed in higher education from mere acquisition of knowledge towards the inclusion of generic skills (Murray-Harvey et al., 2004). According to Casey and Hawson (1993), the focus on cognition tends to be on the quality of the thinking processes rather than the accuracy of the learners' answers. Extensive research conducted in cognitive sciences about the nature of learning, have seen previous focus on teaching moved towards learning (Barr and Tagg, 1995). As a consequence, higher education is challenged to

develop, implement and evaluate instructional practices that are student centred, besides fostering skills and competencies development. Problem Based Learning (PBL) as a teaching and learning approach in higher education that has evolved in many forms is also seen as a way to address the call. From theoretical point of view, PBL could be explained from Kolb´s experiential learning, Schon´s reflective practitioner and Vygotsky´s zone of proximal development. Common view held by these learning theories is that acquiring experience is essential to further process motivation and learning (Kolmos, Fink and Krogh, 2004). As adult learners, students in higher education bring their experience in the classroom and construct knowledge based on their experience and overall views of the world the possessed. This view is known as constructivism (Savery and Duffy, 1995). As a consequence, students are given ownership of their learning and possess higher retention of what is learnt, as they seek meanings for themselves and not meanings held by the facilitators. In its implementation, PBL centres around problems rather than a series of pre-determined content using conventional teaching approaches. Groups of students are presented with ill-structured problem scenarios or cases which they solved collaboratively, usually for a week or longer, depending on the complexity of the problem scenarios. In finding solutions to the problems, students need to apply problem solving skills, critical thinking and content knowledge to real-world and workplace issues. Comparatively, students assume more responsibilities compared to conventional approaches through self-directed learning. PBL which was first initiated in the late 1960s has since been applied in institutions mainly in medical and engineering education. Hence there are varieties of PBL models and approaches being practiced depending on the discipline and the objective of the curriculum. In spite of these variations, they all share common features of PBL which include active learning strategies, project-based or problem-oriented, collaboration and cooperation, and attainment of generic and transferable skills and competences.

In line with the emphasis on student-centred learning in higher education, Malaysia´s Ministry of Higher Education (MOHE) introduced outcome-based education (OBE) (Puteh, 2013). In OBE, the learning outcomes from instruction does not only focus on students' possession of knowledge, but also equipped with appropriate skills and qualities upon graduation. In response to this trend, PBL has been identified as one of several approaches to learning to achieve the learning outcomes correspond to OBE. PBL has been adopted in Malaysia in a variety of disciplines and gained considerable prominence in the fields of engineering, ICT and multimedia, physics, medical and dental education (for example see Barman, 2005; Mohd-Yusof et al., 2005 and Said et al., 2005). Historically, PBL was initially introduced in the Malaysian education context in the health sciences field in the early 1970s. However, its adoption was rather slow and scarcely documented (Achike and Nain, 2005) until in the 1990s when a number of medical and non-medical schools began to introduce PBL in their courses or programmes. For instance, the engineering schools in Universiti Teknologi Malaysia (UTM), a public, technology-based university spearheaded PBL within its engineering faculties with an aim to produce high-quality graduates, equipped with skills in communication, team work, problem solving and life-long learning (Mohd-Yusof et al., 2005). These examples indicate that PBL in Malaysian higher education is more popularly integrated into engineering and medical schools, than in other disciplines especially in teacher education.

In education fields, Casey and Hawson (1993) have examined the application of a PBL approach in the pre-service teacher education and Bridges and Hallinger (1995) employed a PBL approach among school administrators. From the literature review, the

introduction of PBL in teacher education was associated with the need for changes in knowledge, skills and competencies among teacher trainees (Merseth, 1996). For example, Edwards and Hammer (2004) concluded that the PBL approach is particularly suited for teacher education as it offers pre-service teachers the opportunity to acquire skills deemed important as a teacher. Taplin and Chan´s (2001) observed the understanding and development of skills among pre-service teachers. Results of the study indicated that they were able to develop appropriate problem solving strategies skills and understanding in a short time. The results were further confirmed by De Simone (2008) in her studies on pre-service teachers' problem solving skills. Pre-service teachers in a PBL learning environment were found to possess improved skills in understanding and elaborating on the problem, make connections between the solutions and the problem, and used of multiple resources as compared to their peers in a conventional learning environment.

Inspired by the favourable research outcomes regarding PBL implementation both in Malaysia and in teacher education domain, it appears to be a good reason to introduce PBL in the Malaysian teacher education field. Like any other profession, teachers are urged to be more responsive and relevant to on-going changes regarding schools and learners. In particular, the role of today´s teachers is not merely limited to teaching and classroom matters, but also involvement in multiple roles like researcher, curriculum planner, team leader and decision maker. As Dean (1998) reiterated, issues like inclusive classrooms, diversity of school students´s group, and emergence of new technologies and teaching aids present tremendous challenges for beginning school teachers. It is therefore imperative to equip beginning teachers with the necessary skills and competencies deemed relevant to face the reality of managing learning within the complexities of a typical classroom. McPhee (2002) attempts to argue on the similarities between teacher education and medical education according to the following contextual perspectives:

> *"Both medical and teacher education are preparing entrants for caring professions of one sort and another. Both professions would claim to be concerned with the development and wellbeing of the entire person. Both are subject to central governmental control in one form or another."* (McPhee, 2002, pg. 63)

The PBL approach suits very well with science teacher education programmes as there are easily available problem scenarios from practice in the profession, as well as literature related to issues and problems concerning science education in school settings (Peterson and Treagust, 2001). In relation to the design and implementation of PBL as an instructional approach, the goals of redesigning the course were four folds namely to: experience and understand PBL in practice, contribute to the knowledge base of student-centred approaches in higher education, provide opportunities to explore issues related to science teaching and learning, and expose and engage students in authentic learning experiences which would ultimately stimulate them to adopt student-centred learning in their own classrooms later.

2. Research Questions

This paper reports on the employment of PBL in a postgraduate science teacher (referred to throughout as students) education course in Malaysia. The main objective of incorporating PBL in the course was to empower students in the transition from merely acquiring knowledge to application of research skills since the students will embark on their research projects in the proceeding semester. They need to be able to apply the

knowledge gained in the current course to solve problems related to fundamental aspects of conducting their research projects. However, for the purpose of reporting this paper focuses on the following inquiry:

i. What are the students ´ perception of the impacts of PBL on their learning?
ii. What are the students ´ reflection on their PBL learning experience?

According to McPhee (2002), research aims at measuring the impact of PBL on student learning indicates that PBL approach serve to support students in acquiring abilities like communication skills, critical thinking, ability to locate and assess related resources and capacity for problem solving. Several previous studies on student learning in PBL argue the important to include student perspectives and learning process in the effort improve the PBL practice in higher education. Faidley et. al., (2000) and Holen (2000) were in agreement of the importance to understand the group work process since the benefit of PBL is more likely achieved by students through working together rather than individually. Loyens et al, (2006) suggests that in understanding the processes and outcomes of PBL, students´ conceptions of what is means to engage in constructivist learning activities need to be taken into considerations. Likewise, Ellis et al., (2008) emphasized not to assumed students as oblivious participants in blind trials since their creativity and constructive views on their learning process is essential to higher education. These collective descriptions of students´ learning experiences provide insight into their need, expectation, difficulty and challenges. Consequently, it shed light on the nature of organization and delivery of PBL, which in turn will help improve the design of PBL curriculum. Likewise, reflecting on the ways student learn in group and issues they encounter add to the current discourse relating to PBL in higher education and holds the potential to improve educational experience to the learners in general.

3. The PBL Designs for Science Teacher Education

Before the commencement of the semester, the chosen course namely Managing Learning in Science (SBB 6034) was redesigned to suit the PBL approach. Design Based Research (DBR) was employed to develop the course into PBL for a semester (14 weeks), three hours per week. DBR involve:

1) connection between central goals of designing learning environment and developing learning theories
2) development and research are carries out through iterative cycle of design, enactment, analysis and redesign
3) communication of theories and implication to practitioners and education designers (Cobb, 2001; Design-Based Research Collective, 2003)

The contents were rearranged into several PBL problems, group learning processes were organised, role of the lecturers redefined, alternative assessment procedures constructed and a pre-course notes on learning in a PBL developed. Kolmos *et al.,* (2009) reiterated that the shift towards a PBL approach does not only involve change in teaching methods, but a combination of learning methodologies, ways of knowledge constructing knowledge and a scientific approach to understanding are needed. The authors further identified seven elements in the curriculum that needed to be aligned prior to implementing PBL namely; objectives and knowledge, types of problem and projects, progression and size,

students´ learning, academic staff and facilitation, space and organization and assessment and evaluation (Kolmos *et al.,* 2009). The following section describe the PBL course.

3.1 The PBL Problems

PBL is a "problem first" learning approach whereby the starting point for learning is in the form of a realistic and contextualized problems**.** Unlike traditional curriculum contents, which are arranged according to topics, themes or disciplines, the contents of a PBL curriculum are organized around problems. Since the students are new to PBL, it is reasonable for the PBL topics to be sequenced in a gradual manner- from simple problem topics to more complex ones towards the end of the semester. Simple problem topics would have less objectives, more hints, less complex and moderate difficulty compare to a more complex problems. In addition, each problem topics was designed to enable students' engagement in discussions to construct their own understanding, share individual experiences and contribute equivocally in a group (Wood, 1994). Hmelo-Silver (2004) characterized good problems as promoting flexible thinking, realistic and correspond to students' experiences. In this study, groups of students work on three PBL problems during the 14 weeks course interspersed with short lectures, preliminary presentations and reflections. Table 1 showed week allocations, the PBL triggers and deliverables (group-generated artefacts) for each of the PBL problems:

Table 1. The PBL problems

PBL Problem	Duration to complete the task	PBL trigger (ways PBL topics is presented to students)	Deliverables
i. PBL1-Constructivism in science education	4 weeks	Video of a teacher teaching a group of primary school students on *Body Part* topic	Evaluation tools used to assess a constructivism in class
ii. PBL2-Alternative conceptions in science topics	3 weeks	Sample of research findings on *alternative conceptions of light* properties, and an invitation letter to publish a review article from a journal publisher	A review article about alternative conception among students in a chosen topic
iii. PBL3-21st century science learning skills	2 weeks	Poster on a competition to design a 21st century learning school science laboratory	A layout plan for the 21st century science school laboratory.

The PBL problems are not defined rigidly as though there is only one simple and single correct answer. In addition, the problems were developed in such a way that it is related

to several areas of the content across the curriculum leading to multidisciplinary solutions. For example, in PBL1, the students developed evaluation tools in the form of rubrics or checklists to assess to much extend a teacher in the video adopted constructivism principles in her teaching. Hence, apart from acquiring knowledge on constructivism, students also applied their knowledge on how to develop evaluation tools which is a topic in their research methodology course. This approach to crafting of the scenarios assist students to develop a network of ideas and see patterns across problems and enable them to expand and integrate knowledge beyond merely acquiring it from a particular perspective. Each group of students is expected to develop different approaches in dealing with the problems. They will learn more and expand their perspectives by critiquing and arguing with other group members when presenting their findings.

3.2 The PBL Learning Process

The PBL sessions started with a short introduction by the facilitator to the issues, followed by presentation of the PBL trigger prior to the group discussions. A group representative will then distribute the facilitator-prepared learning materials to the group members and collaboratively work towards addressing the problems and issues. Generally, during the first group discussion, students brainstormed the given scenarios, listing out critical information, their thoughts and opinions about it, and finally constructing the questions or inquiry in the form of learning issues. The learning issues form the basis upon which students are guided to conduct further research in finding solutions to the problem. Students also used PBL thinking tool, a table with is four different headings (*Facts, Ideas, Learning Issues* and *Action Plan*) as depicted in Table 2:

Table 2. PBL thinking tool

Facts	**Ideas**	**Learning Issues**	**Action plans**
What do we know?	**What do we think?**	**What do we need to know?**	**What should we do?**
Information extracted from the problem scenarios	Possible causes/effects/ ideas/solutions based on the facts identified	Phrased as questions that lead to the problem solutions	Activities to be carried out to answer the questions
Identification of term and ambiguous notions	Consider to use own experience and previous knowledge	Determine which question is worth researching and list out those irrelevant	Possible resources to consult to answer the questions

Division of tasks

Source: adapted from Dean (2001), pg11.

As students are novice and newly exposed to PBL, filling out the PBL thinking tool helped them in determining the facts contained in the scenario, developing feasible hypotheses underlying the problem and identifying learning issues to research. Students also take on different roles during group discussions such as team leader to steer the group's direction, scribe to compile and document important information discussed, and group members to locate resources related to the problems under scrutiny. Before ending the PBL sessions, each group is expected to divide the tasks among members to be accomplished during the self-directed learning period. Students will mainly search for the resources relevant to the tasks given and prepare drafts of the solutions for the next group discussion. Since most of the students are part-timers and lived apart, they used emails and internet extensively to communicate with each other. They shared and critiqued resources and kept journals to support the group processes during self-directed learning. During the successive meetings, students presented their findings to members of the group, both verbally and written drafts prepared. At this stage, some students draw illustrations, clarified uncertainties and drew connections between their prior knowledge and the tasks under discussion. Based on the collective efforts by each group member, the groups decided on a solution to the problem after reaching consensus following which, a whole-class discussions was carried out. The objectives of the whole-class discussions were to expose students to the solutions from other groups, and broaden their perspectives on the PBL scenario under scrutiny.

4. Methodology

4.1 Research Design

Research design is a plan or framework for a study used as a guide from broad assumption to detailed methods of data collection and analysis. According to Creswell (2008), selection of a research design is based on the nature of the research problem or issues under scrutiny, researchers´ experience and the audiences of the studies. The current research adopted exploratory research design to address the research inquiry. Exploratory research design is deemed appropriate to gain insights, ideas and better understanding of student learning in a PBL environment. To elicit student learning, we employed a multi-method, one group, repeated treatment design (Cook and Campbell, 1979). Multi-methods for data collection includes semi-structured interviews, participant observations, and students ´ written reflections. In our effort to ascertain validity in a qualitative study, Wolcott (1990) principles of listening extensively, writing accurately, seeking feedback from others and reporting fully were adopted.

4.2 Participants

Thirty-two Master of Education (Science) students signed up for the fourteen weeks course conducted once a week for three hours. Of these 32 students, five were males. Most of the students are in service science teachers with varying years of teaching experiences either in the primary or secondary schools. However, there are a number of newly graduated students from an undergraduate programme either in the field of science education or pure sciences. Though some of the students had prior experiences of

working in groups in a PBL environment in their previous courses, a majority of them were not familiar with student-centred, active learning strategies.

4.3 Data Collection

Consistent with qualitative methods, the data were gathered from multiple sources including observations, students written reflection and individual, semi-structured interviews. Observation were made when the PBL groups meet to discuss and understand the tasks: identify the facts and ideas from the scenarios, generate learning issues and hypotheses and finally identify plan of actions towards finding solutions to the problems, record instructional sequences, group process, participant interactions, which included facilitator-group, facilitator-student, and student-student. Observations were documented in field notes. Field notes were used to gathered, record and compile events that took place during the class activity and describe information on what have directly seen or heard on-site throughout the course of the study. Table 3 specify different types of data collection techniques according to weeks and PBL problems:

Table 3: Data collection according to PBL problems and weeks

PBL Task		**PBL1**				**PBL2**			**PBL3**		
Week		5	6	7	8	9	10	11	12	13	14
Data collection technique	Observation	√	√	√	√	√	√	√	√	√	
	Individual written reflection				√			√		√	
	Group written reflection				√			√		√	
	Interview										√

As depicted in the Table 3, observations were made in weekly basis. The students ´ written reflections (individual and group written reflection) were executed right after they completed specific PBL cycles (week 8 for PBL1, week 11 for PBL2 and week 13 for PBL3). The students ´ written reflection consist of individual written reflection and group written reflections. Reflections aims to gather insights on students' learning experiences, make them aware of their own learning, and enhance their meta-cognitive skills in understanding how learning occurs and identify improvements. The individual, semi-structured interview was conducted with eight randomly selected students at the end of the study. Semi-structured interview types were deemed appropriate research method to gain an in-depth perspective of students experience in learning. The purpose of the interview was explained verbally before the interview session. The interviews explore students background information, their experiences in group work, benefits and challenges of participating in the PBL environment in terms of their collaboration with peers, problem solving and facilitation processes. The interview questions were loosely structured to provide opportunity for participants of the study to convey their own views

and experiences (Seidman, 1998). Depending on their willingness to share and talk, each conversation lasted for about 20 to 70 minutes and took place either in the researcher´s office or a campus location at the convenience of the students. All interviews were tape-recorded and fully transcribed. In interview, the response rate is usually good, interviewee may feel more control, statements and opinions could be followed through and misunderstanding could be explained. However, there is also drawback in the interview in which students may give socially acceptable answers or be influenced by the researchers. This is important consideration since researcher is also the lecturer for these students. Observation data in the form of field note guided and informed the development of the semi-structured interview protocol that was conducted at the end of the semester (Week 14). Data obtained from interviews help to triangulate data from written reflection obtained in the earlier weeks. Triangulation is the process of using multiple methods, data collection strategies and data sources to obtain a more complete picture of what is being studied and to cross-check information (Gay et al., 2009).

4.4 Data Analysis

Both data collection and data analysis occurred simultaneously throughout the study. Therefore, the ongoing analysis influences the scope and direction of succeeding observation, written reflection by students and interviews. The interview transcripts and students´ written reflections were analyzed using inductive analytical approach (Thomas, 2006) through detailed readings and interpretations of raw data to generate themes, concepts or models across the data sources. The interview transcripts were read several times to determine topics and sub-topics, which were then coded as categories. The list of categories formed themes after further refinement by comparing each transcript to seek for commonalities and contradictions. Written reflections were individually analyzed and organized to identify themes. In the final stage of data analysis, themes from interview transcripts and written reflections were compared to identify general patterns of similarities, points of clarifications and contradictions. The multiple qualitative data collection strategies and data sources adopted in the study lead to a comprehensive view of the interacting variables and compensates the strength of one particular strategy for the weakness of another**.** To align with Lincoln and Guba´s (1985) suggestion for increasing the trustworthiness of research findings, we used multiple data resource and maintained a detailed research record.

5. Findings and Discussions

The findings were presented and discussed through the use of direct quotes from the interview transcripts and written reflection and compared with related previous research. The different types of data sources were coded as follows; Individual Reflection (IR_#), Group Reflection (GR_#) and Interview (IV_#). Finding on student learning is divided into three main theme; impact of PBL on student learning, student reflection on PBL learning and challenges in PBL learning.

5.1 Impact of PBL on Student Learning

Analysis of the qualitative data through semi-structured interviews and students´ written reflections resulted in two categories for the impact of PBL on their learning namely; *impact of PBL on students´knowledge and skills* and *impact of PBL on student group processing*.

5.1.1 Impact of PBL on students ´ knowledge and skills

It has been a long-held view that PBL enhance the acquisition, development and improvement of students' knowledge and skills. The findings of this study indicates that students were well aware of the knowledge and variety of skills they acquired, developed and improved throughout the course. Students also remarked they apply acquired knowledge and skills on their own classroom and in daily life. Here are some of the related excerpts:

Table 4. Impact of learning on students ´ knowledge and skills

Theme	Knowledge and skills acquisition and application
i. Sub-theme	Knowledge and skills acquisition
Excerpt:	

- Enjoyed, get feedback from peers and improved communication skills (IR_1)
- Encourage creative and innovative thinking, enhanced collaborative and self-directed learning skills, and increase motivation (IR_19)
- Learn a lot even for only one PBL task, content and skills learned simultaneously, improved communications and develop presentations skills (IR_6)
- I learned group collaborations, gained ideas from different people, searching for the resources from several perspectives, improved skills in dealing with a specific problem (IR_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 (IR_3)
- PBL integrate new knowledge with prior knowledge, students become skillful in articulating and presenting ideas. (IR_12)
- Knowledge is constructed, and development of lifelong learning skills. (IR_13)
- Allow students to work independently and creatively, good to hone skills in communications, leaderships and managements. (IR_26)
- Help students to discover structure of their own thoughts, I learned the skills in probing the questions in open-endedly, gather evidence, conclusions, questions, assumptions and implication of a particular problem task. (IR_16)

ii. Sub-theme	Knowledge and skills application

- Foster intrinsic motivation, promote active and deep learning, inspire me to incorporates good practices in teaching and learning in my own classroom. (IR_5)
- Variety of skills developed in PBL class especially skills in group work, and these set of skills are

relevant for current career. (IR_24)

- Interesting, immeasurable experience and content gained, almost like working in the real life situations and understands the idea in a more professional way, skills and practices in group work is important as a teacher. (IR_7)
- Learnt new knowledge in different field from group members, realistic and empowering the students, develop skills relevant to future work, more responsible towards learning. (IR_18)
  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 applied in the daily life. (IR_27)

From the excerpts, it is apparent that PBL helps students developed advanced cognitive abilities such as communication, problem solving, self-directed learning and critical and creative thinking. The group learning process in PBL is associated with the ability to cooperate, leaderships and information managements. The same findings were comparable with previous studies on PBL implementation in teacher education. One such study was by Peterson and Treagust (1998) who developed a PBL learning framework addressing pre-service teachers´ knowledge base for teaching (science content knowledge, curriculum knowledge and knowledge of the learner) and pedagogical reasoning ability (comprehension, transformation, instruction, evaluation, reflection and new comprehension). Using case studies as a way to elicit the effects of PBL, pre-service teachers were reported to develop their knowledge base and pedagogical reasoning which corresponded to their current belief in primary teaching and learning. Murray-Harvey and Slee (2000) also applied PBL in an attempt to help pre-service teachers make connections and apply online learning to real life situations. To measure the impacts of PBL, pre-service teachers´ feedback and peer reflection was used as the main source of data. Evaluation of pre-service teachers´ responses indicated their agreement that PBL processes helped developed their critical skills, reflective skills and skills needed by the teaching profession. McPhee (2002) utilised pre-service teachers feedback on their learning and questionnaires to investigate their experiences in issues-based learning. The pre-service teachers described the main benefit of PBL as a way to improve their communication skills, team work, information gathering and analytical skills. A significant number of responses indicated that learners related the benefits of PBL to the knowledge and skills they acquired, and that the development and improvement were relevant to their current professional practice as in-service teachers and in general to their daily lives depicted in the aforementioned excerpts.

Students also found that the knowledge and skills they acquired is applicable to their daily life and in their own classrooms. As school teachers, the knowledge and skills is important for them to deal with the complexity of today´s classrooms. The findings reported so far, reflected and supported the aims of the PBL scenarios; enabling students to see its relevance to their profession as teachers. In each of the PBL scenarios, students were required to consider intertwining issues including educational policies, learning, facilities and teaching and learning related issues. In developing the PBL scenarios, emphasis was also given to the ill-structured domains that reflected students' real-world experiences. The scenarios were also crafted in a way that required students to apply their prior knowledge and experiences, which were relevant to their current or future profession as a teacher and emphasized on situations in which the learners were likely to encounter. De Simone (2008) reiterated that problem scenarios representing real life

problems enhance students' ability to define problems, generate solutions and application of practical and theoretical-based resources.

5.1.2 Impact of PBL on students´ group processing

Sufficient evidences were found on how students perceived the value of PBL from the group processing point of view. The group processing activities including brainstorming, discussions and locating resources served as an opportunity for them to validate arguments, exchange and expand ideas resulting in better resolutions of the tasks. Presented below are samples of the related claims:

Table 5. Impact of PBL on students´ group processing

Theme	Group processing-related impact on students´ learning
i. Sub-theme	General PBL group processing
Excerpt:	

- "By getting the feedback from our peers in the group, 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 supposed to learn in our class. Getting the feedback from our group members, we can know about our weaknesses."(IV_5)
- "The ideas or the responses were varied and diverse. Sometimes it never across in my mind that the learning issues could be developed in a 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 a variety of answers while learning in PBL."(IV_7)
- Students actively participate in group discussions, since student explore by their own, the knowledge retention is longer, enhance communication skills because of the argument of ideas among group members, problem solving skills, and PBL is a very interactive ways of learning. (IR_20)
- "Stimulate me to think, get the different information and resources from other group members, so we can always have different perspectives in dealing with the task and knowledge sharing."(IV_6)

ii. Sub-theme	Task division to share the workload

- "Stimulate to ask questions further and deeper, will get different kinds of ideas, and can get better ideas, save a lot of time in learning since the burden is divided among the group members." (IV_1)
- "When we get together during the group discussions, we can felt enjoyable,we completed our work together..when we sat n a group, we do not feel the hardships that we felt when we were alone." (IV_2)
- "Looking at the quality of the work, I guess our quality of work is much more higher than if we do it individually, because we shared the ideas and compiled our knowledge together. If we learn individually, we do not have enough time, because we are not sharing the burden."(IV_8)

iii. Sub-theme	Self-directed learning

- Challenge students to think critically, work cooperatively in groups, peer teaching helps in comprehending the content, think out of the box and think from different perspectives, and opportunity to search for a variety of information. (IR_9)
- Help in using appropriate skills, encourage to use a variety of sources. (IR_10)
- Self-directed learning, students become more responsible to their own learning and not dependent on their facilitators, deep understanding of particular contents, possibility to search for information from various perspectives and not bored. (IR_15)
- Active learning, self-directed learning skills, opportunity to explore a variety of information, peer learning (learn many new things from group members), open minded in accepting ideas. (IR_17)

"Getting feedback" and "different views or ideas" from the peers during the discussions appeared to be common in the above excerpts. PBL emphasize on social learning whereby knowledge is socially constructed among a group of learners. To achieve the aim of learning in PBL, an effective group discussions is the key to go forwards. Since discussion stimulate group members to present variety of ideas, students will expose to many possible ways of dealing with the problem at hand. This is one of the paramount aim of any PBL implementation whereby students are encourage to synthesize variety of information and sources to reach the most feasible solution for their problems. Students clearly articulated how group discussions benefitted them, particularly in consolidating different point of views, building confidence, knowledge retention, acquiring skills and learning from each other.

Students' positive thoughts about teamwork and group learning processes included features such as sharing of knowledge, and the potential of PBL in developing and maintaining group learning behaviours. An effective PBL group is dynamic, mutually supportive and cohesive. Each group member understands their tasks and responsibilities, and accomplishing it successfully. Another essential characteristic of the PBL group learning process is to locate relevant information and resources in dealing with the tasks. Suggestions on any specific resources were not given to the students, instead they were given the freedom to search from a myriad of resources available. The following excerpts from individual reflections indicated how students valued the opportunity used to search from various resources. Students were also nurtured to develop more divergent thinking and adopt a flexible approach to integrate knowledge from a wide range of resources. This served as a platform for learners to acquire a deep approach to learning. In PBL, students assume greater responsibilities for their own learning and this include the ability to find, evaluate and apply appropriate resources and information to deal with the problem at hand. Therefore in PBL, students become self-directed in their learning whereby they would be able to set learning goals for themselves, identifying what need to learn more, able to plan on how to achieve the goals, and finally evaluate whether the learning goals have been achieved (Hmelo-Silver and Eberbach, 2002).

5.2 Students´ Reflection on Learning in PBL

Data on student reflection on their PBL learning experience is mainly gathered from their individual and group written reflection whereby students were invited to reflect on their learning process at various stages of PBL activities. Observation and interview further confirmed students claimed in their written reflections. From the analysis results of bot

written reflection, the students reflection could be classified into two perspectives: *reflection on group process* and *reflection on PBL content and delivery.*

5.2.1 Reflection on PBL Group Process

Most of the students reflection on their learning were revolved around the group matters. Students reflection on the PBL group process is further divided into subtheme of; *explicit roles of group members* and *efficient group learning practices* as showed in Table 6:

Table 6. Reflection on Group Process

Theme	Reflection on Group Process
i. Sub-theme	Explicit roles of group members
Excerpt:	

- Good leadership and active participants of group members. (IR_17)
- "Appoint a leader, that could steer our group directions, the leader is there, but the role is not obvious." (IV_5)
- "In task division, it should be equal, leardership role is rotate among group members, finished to deal with the tasks immediately." (IV_2)
- Emphasize the role of chairman, secretary and scriber. (IR_26)
- Good rapport among group members (understanding and cooperation). (IR_17)
- Role of members in discussions should be rotated. (IR_18)
- Specific role of group members in the task. (IR_4)
- If we can divide the task properly and all group members plays their roles, thing would be much more easier (and) the output of the works will have much more standard.(IV_2)

ii. Sub-theme	Efficient group learning practice

- Should put the timeline properly and meet more frequently beyond the class time (Should figure specific time for the group to meet beyond the class time and meet frequently). (IV_6)
- Set the group deadline to collect the documents and data. (GR_4)
- Good time management. (GR_1)
- Emphasize on punctuality to submit the tasks given to each group members. (GR_4)
- Do the discussions more than once and each group members should prepare for discussions. (GR_5)
- More exercise to construct the learning issues during the group discussions. (IR_26)

From the excerpts, students remarked the important of having roles among the group members and to carry out the roles responsibly. For some students, effective leaderships in group is a key to a fruitful group discussions. Others believed it is not only important to assign specific roles to group members, but also to effectively take up their roles by active participations in the group discussions. In addition, the different roles of group members

should be rotated to ensure each members will experience different roles and can contribute from different perspectives during the group learning process. Students´ reflection is aligned with the PBL learning principle whereby learners assume an active role in acquiring new knowledge and skills rather than being passive learner. In a functional PBL group, each group members take up their specific roles and contribute in different way. Students realize the importance of having proper role in group discussions, especially the role of chairman/leader and the scriber/secretary. Indeed, if the role is carried out properly and accountably, it would contribute to a better group performance. According to a student (GR_6), active participation in group is to "share the ideas and opinions, ability to questioning and probing inquiries within discussions".

With regards to student reflection on efficient group learning practices, their reflections call for better planning on group timetable whereby proper timeline on group schedule should be explicit and made known to each of the group members. Proper timeline on group schedule might include the deadline on group work submission, when to discuss beyond the class time and when to gather the data. Since students are live apart from each other, meeting with group members outside the class time might not be feasible since students will only be in the university only when they have classes to attend. However, from this reflection, students realize that they should emphasize on their timetable planning to manage the group dynamics. A proper group timetable planning that are specific, thorough and pragmatic are important considering their backgrounds. This findings give an insight to the authors to encourage students right at the beginning of the semesters to have their own group timetable to manage their PBL learning.

5.2.2 Reflection on PBL Content and Delivery

Apart from reflecting on their learning process, students were also invited to reflect on the PBL content and delivery during their final written reflection on week 13. Student reflection on content and delivery is divided into sub-theme; *reflection on PBL problems* and *facilitation and instruction.*

Table 7. Reflection on PBL Content and Delivery

Theme	Reflection on PBL Content and Delivery
i. Sub-theme	PBL problems and assessment
Excerpt:	

- The PBL problems should be more precise, directive and clear. (IR_4)
- The PBL problems should consider students prior knowledge. (IR_7)
- The PBL problems should be either about current issues or related with the real life experiences. (IR_23)
- More PBL problems in the class for students to really grasp the concept of PBL learning. (IR_24)
- Formative assessment at the end of every PBL sessions.(IR_9)
- The assessment should revolve around PBL, so that students will truly understand what is PBL. (IR_18)
- Emphasize the individual assessment as well, mixed of races in the group, to give some input before

giving the problem tasks. (IV_1 and IR_12)

ii. **Sub-theme**	Facilitation and Instruction

- Suggestion from facilitators on reading materials or resources to facilitate students to deal with the task. (IR_26)
- The instructions should be clearer to better deal with the PBL problems. (IR_6 and IR_2)
- Introduce the concepts of PBL in details to students before employed it. (IR_10)
- Facilitators should facilitate the students when they frustrated, need cognitive supports and issues arising in the groups. (IR_18)
- 2 or 3 days before the class started, lecturer should post keywords of the task in *Myguru* portal to make students prepare and search information. (IR_20)
- Facilitators to gives sufficient time for students to discuss. (IR_1)
- Facilitators should allocate more time for group discussions, because time constraints will effect students´ outcome. (IR_4 and IR_1)

On PBL problems and assessment, students reflect that it should be more directive, clearer, consider students prior knowledge and includes current issues in science education. As mentioned in the earlier part of this articles, these three PBL problems are presented to students in gradual ways, whereby the first PBL problem contain more hints, ques and more explicit compared to preceeding two PBL problems. This is for the purpose of minimizing the tensions among students. These problems are also designed to correspond to student prior knowledgein which students already have the conception of constructivism, alternative conception and 21st century learning in their previous course. This is a kind of dilemma exhibited by PBL facilitators about how much background information to give to students. Referring to both PBL problems and ways of facilitations, the authors are constantly deal with the interplay between giving the ownership of learning to students at one hand, and to give proper and adequate facilitation on another. On facilitation and instruction, student reflection generally call for more facilitations from the facilitators which including suggesting resources, clearer instruction and detail introduction of PBL concepts. Students also need support to deal with the frustration and group issues. Reflecting on time, students would suggest to have more time on their discussions.

5.3 Challenges in PBL Learning

As students are mostly new to the student centred learning like PBL, learning in PBL might impose some challenges as they tried to cope themselves within the new learning environment. Students had to become more independent on their learning and rely on group members as well as confronting challenges of group works while learning in PBL. Apparently, learning in PBL is very different from what they used to. To discuss further on challenges students face, the challenges were divided into three sub-theme which are; *initial anxiety and gradual reconciliation*, *insufficient time* and *group issues*.

5.3.1 Initial anxiety and gradual reconciliation

Anxiety and struggle experienced by the students specifically during the initial semesterwas evidently expressed through both interviews and individual reflections. In fact, previous research has similarly suggested that learners who are new to PBL tend to have difficulties at the initial stage of the inquiry (Brush and Saye, 2000; Land, 2000). Uncertainties and difficulties in dealing with the tasks were the most prevalent comments. Listed below are the related written comments and interview excerpts:

Table 8. Initial anxiety and gradual reconciliation

Theme	Initial anxiety and gradual reconciliation
i. Sub-theme	Initial anxiety and struggle

Excerpt:

- Hard to deal with the tasks at the beginning (IR_25)
- "Unsure about what is supposed to do in the early semester"(IV_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." (IV_2)
- "Not sure what to do at first, but later on more familiar with learning in the PBL environment" (IV_6)
- "During the latest PBL tasks, we are now sure what to do, and convinced about it. But during the first task, we are kind of unsure of what we should do, a bit confuse. We do not know how to fill in the PBL thinking tool, during the second task, we are still not so sure yet. We do not sure where should we go, to which direction we should head for." (IV_5)
- "During the first PBL task, we misunderstood what we should do. Initially, we thought that we need to scrutinize on the content of the video or the content of the lesson the teacher taught. During the first task (in the PBL1: Constructivism), we are still ambiguous on what to do, however we actually became more comfortable when we know what to do ."(IV_6)

ii. Sub-theme	Gradual reconciliation with PBL approach

Excerpt:

- Misconception at the beginning, but later on can work on the tasks confidently guided by the facilitators (IR_8)
- Feel very awkward at the beginning, but with the guidance of the facilitators, I became familiar with the preceding tasks (IR_5)
- "When I entered the class, during the first problem scenario, I was 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 task, I feel so ebullient, because I already knew....Because Dr Sopia (the facilitator) make it like multiple perspectives, not the subject matter one." (IV_7)
- Difficulty in filling up the PBL thinking tool, and understanding the tasks (confuse, misinterpret) at the beginning, but feel good during weeks after. (IR_4)
- Hard at the beginning to deal with the PBL tasks, but soon became more skillful. (IR_19)
- I have some difficulty to articulate the thinking at the beginning, later on, everything runs smoothly. (IR_21)

From the above excerpts, it is apparent that students needed a considerable amount of time to familiarize themselves with the PBL environment. Schmidt et al. (1992) reported that students needed at least six months to adapt to a new instructional method. Furthermore, with regard to the Malaysian context, it is expected that students needed more time to be comfortable with the nature of learning through PBL since their previous learning experiences was dominated by a teacher-centred and rote learning approaches which contradicted with the PBL learning environment. This finding was supported by a study on students' assessment of PBL. In the introduction phase of PBL, Pereira et al. (1993) found that students were cautious of PBL, and to some extent condemned the approach. Nonetheless, over time, the students became more positive towards PBL, partly contributed by the support and commitment from the faculty. The results were similar with Lai and Tang (1999)'s research on learners' responses toward PBL. From the interview excerpts, students were reported to be frustrated at the beginning of the course, largely contributed by their uncertainty and unfamiliarity with the PBL approach. Findings from these studies suggest that as students became more 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 psychiatry course using PBL with the facilitator playing an appropriate role during the preliminary phase.

Initially, the researchers planned to grant the groups complete autonomy to decide on what they want to research on. However, the students asked for more directions and reassurance in assisting them to narrow the scope of inquiry as expected since this is their first exposure to PBL. Hence the facilitators made themselves available most of the time while they were discussing and even offered to meet them after class. Mohd-Yusof et al., (2011) also suggested that Malaysian students needed more motivation, encouragement and guidance at the beginning of the semester, and giving ownership of learning to the learners gradually as the semester proceeds. This is reflected in the comments by students in the current study who were able to cope with the demands of PBL after undergoing several PBL cycles. At the beginning of the semester, students did not grasped fully the principles of PBL. In fact, they gradually enjoyed and became accustomed with the PBL approach as they were familiar and able to embrace it. Findings from Mohd-Yusof et al. (2004) study also indicated that the popularity of PBL increased with more experience whereby 80% of the students mentioned that they preferred PBL during second semester compared to merely 60% in the first semester.

5.3.2 Insufficient time

Time constraint are among the most prevalent issue raised by the students. Comments such as *´insufficient time´* and *´time is not enough´* were typically found in the students´ individual written reflection when asked about the challenges they faced in learning through PBL. In addition, some students even stated the stages of the learning process in which lack of time was exhibited. The following table are samples of written comments and interview excerpts in which claims were made in relation to insufficient time to deal with the tasks, doing the discussions, understanding and completing tasks:

Table 9. Challenges in PBL learning with regards to insufficient time

Theme	Insufficient time
i. Sub-theme	Insufficient time within various PBL stages
Excerpt:	

- "I always feel guilty while doing the group work..because of the late submisison of the work. We do not have sufficient time to deal with the tasks and it is quite difficult for us to meet physically beyond the class time to do the discussions". (IV_5)
- Need more time for discussions. (IR_1 and IR_6)
- Big or higher level problem tasks required more time, at least 2 sessions for discussion. (IR_20)
- Insufficient time to complete the tasks. (IR_22)
- "We expect to complete a task within 2 weeks, but we are unable to complete it due to time constraints." (IV_2)
- Require more time and support to understand a specific PBL task. (IR_7)

ii. Sub-theme	Insufficient time from written group reflection
Excerpt:	

- PBL1

Not enough time to deal with the tasks. However, it was worth to invest such amount of time because this is the first PBL task for this course (GR_3)

- PBL2

No (time is not sufficient), because there is a lot of reading needed to be done (GR_1)

- PBL3

No, we need more time for discussion (GR_6)

No, we do not have enough time to complete the tasks. We felt that we can do better if we can have a bit more time on the tasks (GR_3)

iii. Sub-theme	Insufficient time due to cognitive levels and distance
Excerpt:	

- No experience to deal with the tasks, hence needed more time to complete the assignments. (IR_2)
- I need more time to develop my analytical thinking skills and problem solving. (IR_22)
- Limited time to discuss face to face with group members since all of them are part-timers and stayed far from the university. (IR_24)
- We have time constraint. We could not see or do the discussions so often because we lived far apart. Yes, we do use the email, but of course it is not the same if we can meet and do the discussions physically. If we meet physically, we could talk and argue more. (IV_7)

Students were reported to perceive PBL as too time-consuming despite the fact that they enjoyed working in groups. Insufficient time had been a recurring issue among students

during different stages of the PBL learning process. Students in group mutually agreed that they need more time to deal with the tasks. The above comments were extracted from the group reflections in the three PBL tasks (PBL1, PBL2 and PBL3) for this study. The issue with time is clearly related with the complexity of the PBL scenarios and time allocated for the group to deal with it. Though all three PBL scenarios presented to the groups were multi-faceted and interdisciplinary, each PBL scenario is differ in its level of complexity, hence requiring different amount of time to complete. Research findings from Goodnough (2006) suggest that time allocated to student should reflect the complexities of the PBL scenarios. Some students admitted the reasons behind insufficient time is related to their cognitive abilities and geographical locations:

Similar issues with regard to time were found in Oberski et al., (2004) study whereby students were asked on the least beneficial aspect of PBL. Respondents in the study reported insufficient time to explore issues and doubt whether it is worth the amount of time invested. So and Kim (2009) also reported that 20 students in their study saw PBL as a time-consuming approach requiring a lot of time in solving the problems/tasks. Respondents in a study by Lai and Tang (1999) also commented that the time allocated was limited and would prefer more direct information to deal with the problem/tasks. In conclusion, students needed more time than what was allocated to them for discussion, information processing and developing skills which were deemed important in PBL.

5.3.3 Group Issues

One of the central principles of PBL is that learners acquire knowledge and skills through collaboration with group members. Collaboration allows learners to draw on their group members' perspectives in order to achieve more effective group learning outcomes. From the presentation of the tasks to the group presentations of their problem resolutions, learners brainstorm, negotiate, discuss and argue in their groups. This demonstrates the role of group collaboration in learning and served as a prerequisite for a successful social learning experience. However, data from individual reflections and interviews indicated that there is lack of cooperation among some of the group members:

Table 10. Group issues related to lack of cooperation among group members

Theme	Group issues
i. Sub-theme	Lack of cooperation among group members

Excerpt:

- No cooperation among group members. (IR_22 and IR_7)
- Do not get full cooperation from group members. (IR_27)
- "I feel so frustrated with group members who did not give full cooperation." (IV_6)
- "Lack of co-operation and unequal division of tasks among group members."(IV_2)
- Insufficient cooperation among the group members…lack of analytical thinking skills and problem solving skills. (IR_22)

ii. Sub-theme Taking advantages from other group members

Excerpt:

- "One drawback of PBL is taking advantage of the group members' abilities." (IV_7)
- "I´m the only one who had to do extra work since I´m good with English, I have to do many parts of the writing, especially the discussion section which required good command in English."(IV_1)
- "Feeling of doing more than the other groups, but getting the same marks. I have to do more work as a leader." (IV_3).

iii. Sub-theme Difficulty in meeting group members beyond class time

Excerpt:

- Difficult to meet group members beyond class time (IR_10, IR_11, IR_15, and IR_27)
- "Not easy for us to meet beyond the class time....that is among the issues that needed to be prevented." (IV_4)
- Difficult to meet with the group beyond class time for discussion since group members stay far from each other.(IR_9)
- Group discussion in class is only for brainstorming ideas, for the rest of the discussions, it only can be done via email or phone calls, which in turn will affect the productivity.(IR_26)

Possible reasons for the lack of cooperation mentioned are understand of the roles of each member in the group. Effective PBL groups require group members to engage with each other and adopt a contributive role during discussions, especially the leadership role in steering the group directions, determining equal distribution of tasks and ensuring that group members are able to achieve the learning outcomes within the allocated time. As a consequence of this, some students felt that the group members took advantage of the situation. Some group members seem to have the tendency to take advantage of their group members' strength, rather than addressing weaknesses that a group member possess. Again, this is related to the roles they adopt and taking turns to take up different roles during group discussions. Ideally, groups should not only assign a specific role to each member, but ensure that everyone were exposed to and experienced different roles such as taking turn in writing on the common board, leading the group discussion, or acquiring information relavant to the problems/scenarios. By doing this, each group member will have the opportunity to develop different skills and competences. Spronken-Smith (2005) study also found that many students commented that they did not gain the new transferable skills because group members made use of their strengths to do tasks they are good at. Other concerns raised with regard to group conflict are meetings with the group members beyond class time raised below.

Problems with meeting the group members is the main group conflict since most of them either individually or groups agreed that they do not have sufficient time in different phases of the PBL learning process. They were not able to complete the tasks within the allocated time, hence meeting with the group members after class was a way to address the shortcomings.

6. Conclusions

PBL is presented in the form of three PBL tasks that were designed in a way that expose students to an interdisciplinary learning context, enhanced their generic skills and at the same time addressed the acquisition of content knowledge. This study elicited the learning impact, the reflection and challenges of learning in PBL environment among the in-service science teachers. From the analysis of data, initial anxiety and insufficient time were two main challenges raises by the students. By engaging in PBL approach meant that students were challenged and had to confront learning in a different mode they use to. The results of this study also suggest that facilitators play significant roles by guiding and coaching to ease the anxiety and struggles faced by learners during the early PBL tasks especially in the early phases. In terms time insufficiency, students indicated that they needed more time during discussion, deal completing tasks, meeting group members and understanding the PBL tasks itself. Reflecting on the PBL design, implementation and evaluation the following considerations for future development of a PBL are highlighted;

i. The need to adjust and adapt the design with the contextual dimensions that is feasible and corresponds to specific contexts.
ii. The importance to be aware of and realize how the contextual elements support or form barriers in implementations.
iii. The utilization of students´ learning experience to inspire the betterment of the PBL design and delivery

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