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Using teaching resources to help students develop team and project skills pays off, both in terms of employability and shorter study time.

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Abstract

Since Aalborg University in Denmark was started in 1974 it has been using a special educational model, where Problem Based Learning is the turning point. Each semester the students on the Engineering Educations form groups of approximately 6 persons, which uses half of the study time within the semester to solve and document a real-world engineering problem.

Working with problems gives the students a very deep learning of the subjects they study, but also very good problem solving skills and team work competencies that are highly recommended by the Danish companies. In the first years of the university many students had difficulties with practical issues such as collaboration, communication, and project management. An important aspect of the basic part of the education (first year), has therefore been the development of a course where the students gets tools and tricks for good communication, collaboration, learning and project management (CLP).

Although the course was a good help to a lot of students it was not everyone that was using the tools in their project work, and since it is only possible to learn about these issues by actually doing them the students had to deliver not only a written report documenting the results of their project, but also an analysis of the working process getting there. Since year 1998 the teachers giving the CLP course have focused very much on these process analyses and as they are a part of the examination the students also have focused more on how they work together and plan and do the project. This has clearly improved the students team and project work skills, which the CLP-teachers can see and document because they have read all of the process analyses every year since year 1998.

This paper will explain the content and the form of the CLP-course and give some examples of the student's exercises and outcome of the course in terms of the process analyses. Results from a new Danish survey will document that not only are the engineering students from Aalborg University highly requested by companies, but there is also a much lower drop out rate among the students and a dramatically higher rate of students finishes their study within the prescribed time, compared to other Danish universities and engineering schools.

Keywords: Problem-based learning, Active and Cooperative learning, Development in teaching and learning.

1. Introduction

The author has been part of the Aalborg experiment for many years starting as a student thirty years ago and later on working as a teacher and supervisor but also doing research together with colleagues in the area of, how the students learn to be competent team workers. The research was mainly carried out as action research, as we at the same time were engaged in developing the problem-based and project-organised study by experimenting with our own practice. Over the last eight years, we have also been part of a group of teachers, who has agreed to do experiments together and afterwards share experiences. We believe that a study model such as the Aalborg experiment is dynamic, always changing through a process of continuous experimentations and

reflections. Through our own experiments, we have developed what can be regarded as a toolbox containing different practical ways of teaching group dynamics.

From our own practice, we know that students working in groups often find it difficult to collaborate and to benefit from being a team. Typical problems, which they are facing, are:

- They have different ambitions and different ideas about, where to focus in the project that they do together.
- They have none or very little experience in project management.
- They do not know how to handle a conflict between group members.

- They are not used to motivate themselves to learn.
- Often they do not know how to handle a meeting in an efficient way.

It seems obvious that they need teambuilding. This is documented by [1]. A special course has been developed to help the student learning Cooperation, Learning and Project Management (CLP). In this paper the theory and methods used in the course will be presented together with the outline and content. Some examples from the toolbox used in the course will demonstrate how it is done in practice. Documentation of the outcome is presented by examples of the students own analysis of the learning process from their process analysis. Results from a survey on the Aalborg experiment seen from a student's point of view will elaborate on their outcome of problem solving projects and team work, especially why it minimizes both the students drop out rate and the time used to finish the studies. These results will be the basis for a discussion of the influence from the CLP-course on the Aalborg experiment.

2. Theory and methods

The theory behind the way team building and group dynamics is introduced in the CLP-course is best explained by introducing a special version of Kolb's learning circle, [2] with extra words (in italics) paraphrased by the author (see Figure 1). Kolb's learning circle describes how people learn either from their own experience or from abstract theories. Kolb calls this the perception dimension of learning. The knowledge can then be transformed through a reflective process or through carrying out experiments. This is the transformation dimension of learning.

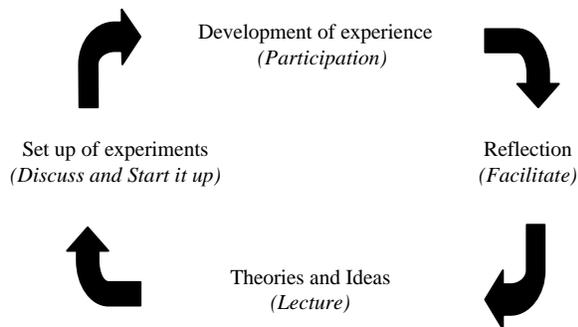


Figure 1. Kolb's learning circle [2]. The authors paraphrase the words in italics.

This model is used to explain how a CLP-teacher can help the students through respectively the perception and transformation dimensions when learning group dynamics. According to the model the teacher can take initiative to create a learning environment based on reflections and experimentations. The teacher may give a lecture with inputs and ideas on, how to improve practice within the group work. To follow up, he/she can help the students prepare experiments for them to try out during their project work in their group before the next course session. During the next session, the teacher can facilitate reflection by asking reflective questions about the experience gained by the students participating in the experiment. By acting reflective and experimenting, the teacher demonstrates to the students that this is a fruitful way to develop both project work and group dynamics.

3. Outline the first year and course content

When students enter the University they have only limited experience with large scale project work (more than two months), especially when it has to be done in groups of 6 students. To give them some quick experiences to reflect upon the engineering students start out doing a smaller pilot project (P0) the first month (see Figure 2). They have app. half the study time to do the project and in the rest of the time they follow courses in e.g. math. In this period the CLP-course consists of two lessons (four hours each). The first lesson introduces the course and study form and explain that the P0-project is a trail and error approach where it is basically left to the students to do a project on their own and to document it in a 20 pages written report. The only help they get is the introduction lesson and 2-3 meetings with a supervisor to discuss the project they have chosen and its progress.

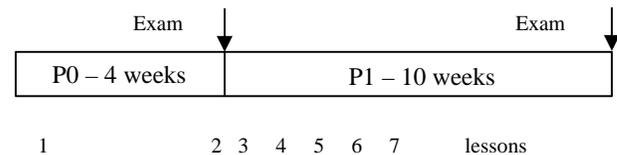


Figure 2. Outline of the first semester, with CLP-lessons and examinations.

When they have finished the project report the second lesson of the CLP-course is held as a reflection seminar where the students in cross groups discuss the lessons learnt in terms of cooperation, project management and learning. After the lesson the students go back in their own group and write a process analysis about how things happened in their group and how to improve the performance in the next semester. The succeeding P0 examination is a reflective evaluation,

starting with an oral defence by the students (½ hour) of both the project report and the process analysis where both issues are assessed afterwards.

The rest of the first semester the students have to do their first larger project and they now form new groups and choose projects themselves within a given theme. Having done some mistakes in P0 the students have realized the necessity of experimenting and reflecting, but also listening to good advises, and most of them want to try out the tools presented in the CLP-course. The content of the five lessons given in P1 is:

- PBL, Cooperation and Supervision
- Learning style and project management
- Communication in and from the group
- Presentation and documentation skills
- Preparation of the process analysis

The last task in the first semester for the CLP-teacher is to read the process analysis and make a written comment with some reflective questions to be used by both students and examiner at the P1 examination where both the project report and the process analysis are assessed and like in the P0 examination the students have prepared an oral defence (1 hour) starting the examination. It takes up to five hours to assess a group and the students are marked individually.

The huge focus on team and project working skills in the first semester is very helpful for the students and to keep up the good performance two CLP-lessons are given in the beginning of the second semester where the students work with one large project and have a lot of technical courses to support it. The CLP-course addresses the need for progress in the team working skills by continues reflections and experiments and the titles of the two lessons are:

- Conflict handling
- The individual person within the group

The examination of this last semester of the basic education is similar to the P1-examination, but this time an external (outside AAU) censor is used and regarding to the process analysis the assessment is focusing on whether the group actually have proven to be reflecting and experimenting. If this is the case there is a high possibility that the students will do continues improvements on their team and project working skills through out the rest of their education.

4. Examples from CLP-toolbox

This section will present some specific examples of the tools used in the CLP-course.

4.1 Cross group reflection

The cross group reflection in the second CLP-lesson is a discussion of P0. The students divide the lessons learnt into good and bad experiences and analyze them by asking why it was a good experience and why the bad experiences went wrong. Using the experiences from the other groups they transform the bad experiences making suggestions for a better handling in the next project. To share the cross-group work there is a poster session.

4.2 Cooperation agreement

To remember and use the good advises for P1 made in the cross group reflection and suggested in the process analysis the groups are advised (in CLP-3) to write a cooperation agreement for P1, addressing issues as:

- Expectations and ambitions?
- What if somebody is late?
- Organizing meetings, chairman, note taker, use of blackboard? How often?
- Division of labour?
- What kind of response do you give each other?
- To what extent will we socialize together? When?

Being a result of a reflection on action (P0) the cooperation agreement is an experiment and when it is assessed, either in a group meeting or by the process analysis at the P1 examination the students start on a second turn in the Kolb circle (see Figure 1) heading towards continues experiments.

4.3 Tests and plays

In some of the CLP-lessons tests is used to exploit the students preferences for learning (e.g. Felder-Silvermans learning style test [3]), team roles, communication style (assertive, aggressive and submissive) ect. The testing of preferences is followed up by guided reflections in the student groups about how the new knowledge about individual preferences and behaviour can be used to improve learning, team work and communication. In the process analysis the group can elaborate on whether this was helpful for their cooperation or they might use the test results to explained why something went wrong.

Plays and exercises is used to stress certain points like the synergy effect of co-working in a group and difficulties but strength in making consensus decisions.

4.4 Communication diagram

A simple tool to point out possible problems in the communication within a group is introduced during a play in the lesson about communication (CLP-5). The idea is to show the communication pattern by drawing arrows from speaker to listener (see Figure 3).

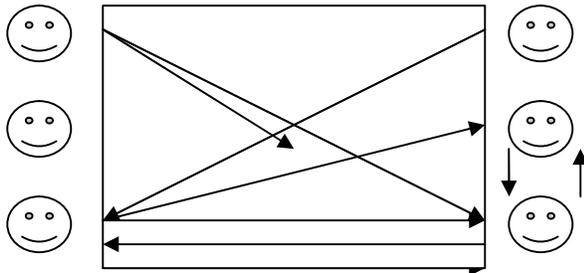


Figure 3. A Communication diagram is drawing arrows for each contribution to a discussion for about 5 min.

Such a diagram will show if there e.g. is two persons arguing strongly for their own beliefs (power struggle) or 2 persons is talking only to each other about something else and the group can then reflect upon the pattern and try to improve their communication.

4.5 Role play about conflict handling

In the CLP-lesson on conflict handling a tool named movement is introduced to explore creative solutions to a specific problem. The idea is that when a conflict is identified and everyone in the group sees the problem, it is better to create a NEW solution than to have a huge argument about which one to choose. In the new solution everyone wins something, but at the same time you also let go of something. The rules for movement are:

- When someone makes a suggestion you are not allowed to question it or criticize it
- You are only allowed to say YES AND ... to spontaneously follow up the idea
- Movement then becomes playing with ideas that is allowed their own life and grows
- The wilder the idea the better
- Even though you don't like an idea, following up on it might end with a brilliant idea later on that might lead to a new solution to the conflict

When running out of ideas the movement stops and the students can look on the conflict with new eyes and one of the wild ideas may be transformed into a new solution that everyone thinks is good. This way the conflict is solved and a win/win solution for all is created. In the CLP-lesson that is placed early in the second

semester the students try out a movement in a role play in cross groups about a typical group problem/conflict, so they get familiar with the tool in secure surroundings before they run in to conflicts in their own groups.

5. Results

The outcome of the CLP-course is a result of a learning process for each individual student, which is hard to measure, but in the process analysis each group analyse their working process for each of the three projects in the first semester, and by reading these process analysis it is possible to see what a group of students have learned according to the topics of the CLP-course. Unfortunately almost every report from the first year is written in Danish, so it is only possible to give examples from one analysis from P2 written in English. This is supplemented with examples from P0 and P1 from process analysis from an introductory semester for foreign students (seventh semester) who comes to Aalborg to get an international masters degree. This introductory semester is run only for foreign students and almost equal to the first semester for danish students. The CLP-course on the introductory semester is slightly different to the corresponding danish course because it also addresses cultural diversity.

5.1 P0 process analysis 2001

The following is copied from a P0 analysis report, 7th semester introduction 2001 from the specialization in Intelligent Multimedia:

“After a difficult beginning, we think we have “found our bearings” for a group of 6 people. In this sense, we think we have learned to work together in a way that is both effective and pleasant. During the first meetings it took us some time to know each other and to learn about each others’ personalities and skills. Because of the fact that we’re a numerous group, we believe this process must have taken us longer than other groups’. Also from the beginning, group meetings have been quite orderly, with people occasionally missing meetings to attend personal engagements or to run errands. In this case, all the members of the team agreed to respect each other’s responsibilities. However, we have found that it’s not very good to miss group meetings or lectures, because then it is difficult to make decisions if we’re not together or if we don’t all know exactly what we’re talking about. Also, in the beginning we had a problem with time co-ordination. Sometimes we didn’t find all the people in the room, and so we would leave to look for a book in the library, for example, and so there would be nobody in the room and we would start the meetings late. But after a

while we learned to avoid these problems and to work better together.”

“In order to take advantage of the things we do well, avoid those that we don’t, and improve the ones that we can, we have set up some rules for our work to come in P1. These are:

- The group undertakes to consult regularly with the supervisor, at least once a week.
- Each member of the group will be punctual for the meetings.
- The 6 members of the group will be present during the meetings, except in case of a previous agreement with the entire group.
- A minute will be written on every meeting by a secretary.
- Each member must have the possibility to talk and to give his opinion about a subject when he or she wants. The time each individual takes to do this will be respected.
- The work to do will be shared in a fair way.
- Every member will respect the other members as individuals, with their similarities and their differences.”

5.2 P1 process analysis 2004

The following is copied from a P1 analysis report, 7th semester introduction 2004 from the specialization in Biomedical Engineering, from a group with 5 members:

“Do we ever change? Our group is rich in terms of cultural diversity. That cultural diversity comes with the price drastic differences such as study styles, perceptions, prioritizing and timing. Would it be possible for us to change and adopt a common approach? At the begging of the project such an idea perceived as impossible but as time passed our mentality changed. It is true that man is a creature of his environment, he can adapt to different environments. We did change.

Positive expectation of members: Promoting positive expectation of group members in terms of ability. Members were encouraged to influence events and share relevant or useful information.

New ideas: New ideas were welcomed from members based on their respective knowledge and expertise. Whenever a challenging situation presented itself, each member was given equal opportunity to express their opinions; however the member who possessed knowledge in the related background was given a leading role to do the follow-up.

Advice:

- Brief group on your progress report. Documentation is important rather than relying on mere words.
- Make sure that every members of the group gets a crystal clear problem statement
- set a strategic objective
- identify barriers to team performance
- Be a good listener.
- Ensure group task is completed and get feedback from the supervisor once a phase of the project is over.
- It takes a while until all group members resort to a common study style. It might happen they never be able to bridge that gap.”

5.3 P2 process analysis 2000

The following is copied from a P2 analysis report, from a group with 7 members studying Informatics second semester:

“Assignments: There were many different working qualities in the group. Some were good at programming and others were good at usability testing and so on. We made a group role test, which told us what each of us were good at, we took it again at the end of the project, to see if we had evolved. We divided the assignment between us, after wishes, knowledge, ability, mental energy and time. In case there were assignments no one wanted, we looked more at the quality and abilities of each member and decided which one should take it.

Collaboration Agreement:

- We are all under obligation to attend meetings. If it is impossible to make it, notify another member of the group. Cell phones must be silent.
- A laptop will be used to take summary at meetings with the supervisor. Everyone must get a copy.
- Group meetings must be at least once a week.
- Relevant materials must be handed out the day before meetings, latest at 10pm. This must be read before the meeting. If the materials did not get out in time, there will be time to read it to the other group members at the meeting.
- In order to keep up the serious work, there must be breaks to relax and “have fun”.
- If a member of the group has difficulty getting started, we are all under obligation to help the member getting started.

- If anyone has a problem with the group, the project or any other conflict, it must be discussed and a solution must be found ASAP!”

5.4 Students view on team work and problems in projects

The following is quoted from interview’s with 4th semester engineering students at Aalborg University [4]:

”I think that it becomes easier when you learn technical matters in groups. Normally we use the blackboard to discuss things. ... You gain more from the time you have to spend in the university in this kind of education when you work in teams. We are getting energy in this way.”

”Working in groups we get mental support from each other; it is also a responsibility so that we won’t drop out easily.”

”We are engineers – our responsibility is to solve real technological problems.”

”This is the first time we found a real problem ourselves rather than getting something from supervisors. It is really exciting. It fits my way of learning. I learn better when I find the way myself. This way of learning is much better than only attending lectures, because I have to know why I need to learn this. When I know the objective clearly, I learn much better.”

”When working on a problem, I am strongly motivated and attracted. We need to solve this problem.”

5.5 Results from Danish surveys on engineering educations in Denmark

In February 2004 the Danish engineering newspaper “Ingeniøren” published the results from a telephone survey with managers from the 500 biggest industrial companies. They were asked about their view on qualification of newly educated engineers from Aalborg University (AAU) compared to the Danish Technical University (DTU) running a more traditional educational system. The new engineers from AAU were ranked to be most qualified in all categories from teamwork and project management to technical skills.

In June 2005 the Danish Rectors' Conference published a survey on dropout rates and finishing time among Danish university students. In this survey there were a significantly difference between AAU with a drop out rate of 8 % compared to DTU’s 31 %, and the numbers for students finishing their studies in prescribed time were AAU 68 % (+ one year 85%) and DTU 9 % (+ one year 44 %).

6. Discussion

When the Aalborg experiment started some of the largest danish engineering companies were convinced that project work was a wast of time, but they surrendered quickly and rankes the AAU engineers as the best qualified (5.5) educated in Denmark. The educational system at AAU also has a very low studytime an drop out rate (5.5) so it is far more efficient than traditional educational systems. This is supported by the students (5.4) with comments like: “Working in groups ...responsibility so that we won’t drop out easily.” “I learn better when I find the way myself.” “When working on a problem, I am strongly motivated and attracted.”

The results from the process analysis shows clearly the progress in the students team and project skills, with the first advises (5.1) being mostly a declaration of how they want it to be (“the group will be ..”) moving towards more constructive advises after P1 (5.2): “make sure”, “set”, “identify”, and getting even more operational in P2 (5.3): “If it is impossible to make it, notify ..”, “If ... did not ...there will be...”. At this point most groups also starts to handle conflicts “ASAP” and the basis for continues improvement is laid. This proves that the CLP-course and the structure of the first year of the engineering education at AAU creates the foundation for the continues development of the students team and project skills so it seems fair to say that the ressources used on this pays off.

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