Does increasing student activity and reducing lecturing improve learning outcome in courses?

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INTRODUCTION

Since Aalborg University (AAU) was founded it has been using an educational model, where Problem Based Learning is the turning point. Each semester the students form groups of, 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 both highly appreciated by the Danish companies. An important aspect of the first semester of the education is a course where the students get tools and tricks for good communication, collaboration, learning and project management (CLP).

Traditionally this course contains 50% lecturing and 50% exercises solved together in the project groups. Based on students assessment of the course in 2012 it was decided to change it in the autumn 2013 trying to activate the students even more by decreasing the lecturing to only 20% using more time and effort on exercises (70%) to be followed up by reflective dialogue with the students about lessons learnt from the exercises (10%).

This paper describes the setup of the traditional and the new version of the course and analyses the effects of the change by comparing two cohorts of Software Engineering and Computer science students from 2012 and 2013 both regarding the student groups use and development of team work competencies which each group documents in a written Process Analysis and regarding individual answers from the students to relevant exam questions taken from a written 7 hour exam.

1   BACKGROUND

The author has been part of the Aalborg experiment for many years starting as a student almost forty years ago and from 1980 working as a teacher and supervisor. I believe that a study model such as the Aalborg experiment is dynamic and always changing through a process of continuous experimentations followed by reflections on the outcome of each experiment identifying strength and weaknesses to plan the next step in the route of continues improvements. Since 1999 I have researched in the area of how the students develop team work skills. The research is carried out as action research, as I am developing and teaching the problem-based and project-organised study and at the same time collecting data documenting the outcome of my experiments.

1.1 Experiences with first year students

From the practice in Aalborg it is know that as freshmen students working in groups often find it difficult to collaborate and to use their full learning potential from being a team. Typical problems they are facing:

- They have different ambitions and different ideas about where to focus in the project.
- They have none or very little experience in project management of large projects.
- They do not know how to handle a conflict between group members.
- They are not aware of how they learn individually and of the power of learning together (Peer learning).

It seems obvious that teambuilding and help to develop team work competences could be very useful for the new teams. This was documented by Professor Kolmos in 1999 [1]. To improve the potential of project work a special course is offered to help the students develop their skills in cooperation, learning and project management (CLP).

1.2 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 in *Fig. 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 trough a reflective process or through carrying out experiments. This is the transformation dimension of learning.
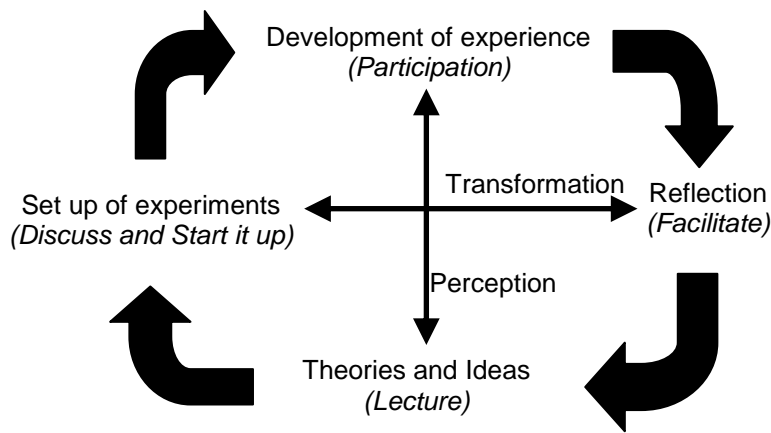

Development of experience
(Participation)

Set up of experiments
(Discuss and Start it up)

Transformation

Reflection
(Facilitate)

Perception

Theories and Ideas
(Lecture)

Fig. 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 experiments and reflections. 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 to carry out during their project work in their group before the next course session. During the next session the teacher can facilitate reflection by asking reflexive questions about the experience gained by the students. By getting the students to experiment and reflect the teacher not only guide the students in one tour round the Kolb learning cycle but also demonstrate that this is a fruitful way to develop both project work and group dynamics.

1.3 Outline of the first semester and the CLP course

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 experiences to reflect upon the engineering students start out doing a small pilot project (P0) the first month of their study as shown in *Fig. 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 explains that the P0-project is a trial and error approach where it is left to the students to do a project almost 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.
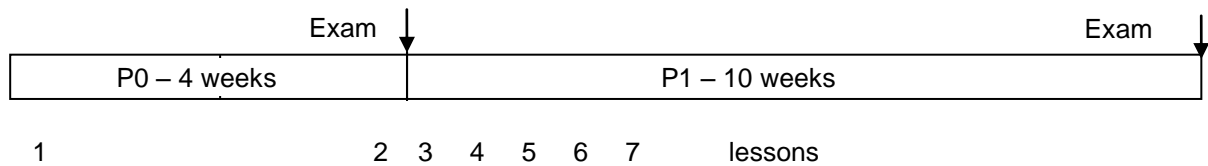
Fig. 2. Outline of the first semester, with CLP-lessons and examinations.

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 project. 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:

• Learning styles and project management
• Cooperation, Supervision and Communication in and from the group
• Creativity
• 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 reflexive 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.

1.4 Focus for this paper

This paper will focus on investigating the outcome of the CLP-course on what we consider to be the most important topics from the course in terms of improving the students' team work skills:

• Supervisor or facilitator types
• Learning and Learning styles
• Roles and functions in the team
• Conflicts and conflict handling
• Project management

These topics are covered by the two first lectures in the list from section 1.3.

2   CLP IN SOFTWARE ENGINEERING AND COMPUTER SCIENCE 2012

September 2012 a total of 142 students started on the educations in Software Engineering (92) and Computer Science (47). The curriculum for the two educations is identical the first year and at lectures the students is in one class but when working in teams Software Engineers are teamed up with SE students (14 teams) and the CS students formed 7 teams.

2.1 Outline of the focus topics in the CLP-course 2012

The focus topics from 1.4 were covered by 2 lectures each followed by exercises solved in the teams.

The two lessons (4 hours each) were placed in the beginning of the P1 period as lesson 4 and 5 in *Fig. 2* (second and fourth week of P1).

The first lesson focused on the topics: Supervisor or facilitator types, Learning and Learning styles and Roles and functions in the team. The topics were presented and discussed in two lectures (app. 45 min each) and then the teams worked in their group rooms for two hours solving the following exercises:

• Take Felder-Silverman's learning style test [3] and discuss how the team can benefit from the knowledge of the test result when trying to learn to and from each other (Peer learning)
• Which formal roles is used in the team (moderator, referee, coordinator, contact person, etc.)? Who is in charge of what? How do you assess the roles?

During the exercises the lecturer and two other assisting teachers visited 7 teams each focusing on questioning the team answers to help them set up good experiments according to 1.2 and enforce their reflections on former experiences relevant for the discussions.

The second lesson followed the same outline with the lectures covering the topics: Conflicts and conflict handling and Project management of both time and resources. The exercises were:

• Surf the internet for sources about conflict management and chose a paper or a chapter that you think could be useful to solve an eventually conflict in your group. Based on the chosen ideas formulate a procedure for how to handle future conflicts in your team
• Make a time schedule on the overview level for your project work. Start e.g. by identifying the big activities and plot them in a flow chart
• How will you handle the project management tasks/issues in your project group: What managerial tasks do you have and who is responsible for them

2.2 Student assessment of the first semester 2012 with suggestions for change

At the end of the first semester the students assesses all the courses and the projects. Based on written assessments from each team a meeting is held where the coordinator of the semester together with one representative from each team discuss what to write in the semester report with focus on wishes and needs for changes. Although the students are generally satisfied with the semester project and all the courses there is always suggestions for improvements.

After the 2012 autumn semester the students suggested that the teachers in the CLP course should talk less in the lectures and use fewer slides. They also noticed that some of the lessons weren't "just in time" either a little ahead or behind the actual needs in the project and they suggested to compress the course using longer and fewer lessons. Based on the discussion with the student representatives the coordinator also concluded that the lessons might be more efficient for the students if they were run in smaller "classes" (e.g. 50 students) instead of one big cohort of 150 students.

3   CLP IN SOFTWARE ENGINEERING AND COMPUTER SCIENCE 2013

September 2013 a total of 177 students started on the educations in Software Engineering (124) and Computer Science (53). This year the Software Engineering students formed 18 teams and the CS students formed 8 teams.

3.1 Outline of the focus topics in the CLP-course 2013

Based on the students' assessment from 2.2 it was decided as an experiment to change the course to meet all the suggestions. All of the focus topics should be addressed in only one lesson taking up a whole working day placed in the very first week of the P1 period. The lesson should be given in "classes" of no more than 60 students so it was necessary to repeat it three times.

The schedule for the students is very compressed in the first week of P1 and all the other lectures was given for the whole cohort so it was impossible to find 3 whole days to place the lessons. The solution was to run all three lessons in parallel in three smaller lecture rooms with app. 60 students and one assisting teacher present in each room all day and the lecturer moving from room to room giving small introductory presentations to start a topic. After a one hour exercise where the students worked in their groups in the lecture room with the assisting teacher present to help them the lecturer came back and collected answers and ideas from the students on the exercise in a plenary session enforcing the

students' reflection on the topic. Keeping up the time schedule in *Table 1.* it was possible to cover four topics this way in one day with each class starting half an hour delayed.

Table 1. Time schedule for whole day lesson for three classes working in parallel.

Activity room	A	B	C
Introduction topic 1	8.15	8.45	9.15
Exercise 1 + small break	8.30	9.00	9.30
Plenary + Intro. topic 2	9.45	10.15	10.45
Exercise 2	10.15	10.45	11.15
Lunch break		12.00-12.30	12.00-12.30
Plenary + Intro. topic 3	11.30	12.30	13.00
Lunch break	12.00-12.30		
Exercise 3	12.30	13.00	13.30
Plenary + Intro. topic 3	13.30	14.00	14.30
Exercise 4 + small break	14.00	14.30	15.00
Plenary	15.15	15.45	16.15
End of lesson	15.30	16.00	16.30

3.2 Content of whole day lesson

The focus topics from 1.4 were merged into the four topics of the one day lesson as follows:

topic 1   Learning and learning styles
topic 2   Different roles in the team
topic 3   Time Schedules
topic 4   Cooperation with supervisor, Communication and Conflicts

The number of slides used to discuss each topic in 2012 was reduced with app. 50 % both to follow the students' suggestions and to enhance active learning by only introducing a topic very shortly and e.g. motivate it showing a short inspiring video. By reducing the time used on lecturing it was possible to enhance the time for student activity (exercises) and make it a more intense experience with 8 teams working in the lecture room guided by an assistant teacher. The exercises used were:

1. Learning Styles:
Take Richard Felder's learning style test (ILS):
Read the small 4 pages hand-out "Learning Styles and Strategies" and discuss how each of you can improve his or her learning possibilities.
Discuss with your group how to best learn to and from each other based on your new knowledge about each team members individual learning styles, both in connection with gaining and sharing new knowledge in your project and solving exercises together in courses.

2. Team Roles:
Find out which roles in the team each of you prefer according to Belbin's Team Roles.
See Belbin Team Mapping Video and "calculate" if your team has any Surpluses or Void's. If so, then discuss how to avoid the Surplus traps (exaggeration) and how to secure (who, how to make sure the others are supporting) that eventual Void roles are played.

3. Make a time schedule:
Your group is having a party on the coming Friday.
You have decided to make a three course diner using the recipe's below. Tree of the members of the group have volunteered to make the food. Help the tree to make a precise time schedule for shopping, preparing and cooking/baking the dishes including who is to do what when.

The party starts at 19.00 and the first course is expected to be served at 20.00.

4. Solving conflicts:
Four of the most common conflicts are:
• A group member starts getting late every day and don't show up at the weekly supervisory meeting
• The performance from the different group members are very different and one member don't finish his tasks at all
• Some of the group members don't respect the group contract
• The group has chosen one member to be the leader but one of the members don't respect the leader

Choose two of the conflicts and discuss what to do if they happen in your group. Try to generalize from the discussions and formulate a plan to follow whenever you spot a conflict, trying to solve it.
Surf the internet for inspiration.

In 2.2 the students' noticed that some of the lessons weren't "just in time". In planning this experiment I tried to make the one day lesson more "in time" than the two lessons was in 2012 but both the fact that each team progresses in different speed and placing four topics on only one day makes it impossible to make all topics "just in time". Learning styles and team roles needs to be discussed in the very beginning of a project which was the reason for placing the lesson in the first week of the project period.

The need for Time schedules is very different from team to team especially when to make the schedules so this topic can never be "just in time" for more than a few teams and almost all teams usually rejects to make a time schedule the first week of the project. Due to these facts the idea behind the exercise was to let each team experience the challenge and strength of planning how to use time and people and with a collective reflection and collecting of positive experiences in the plenary session to enforce and inspire the teams to make time schedules for their own projects when needed.

Conflicts happen at different time in different teams and if it happens it is often difficult to discuss in the team because some of the team members are already a part of the conflict. From many years of experience the teachers know that there is a big chance that each group within the first year of their study will experience one of the four conflicts listed in the exercise and the idea and hope behind the exercise was that by discussing how the team could handle a specific conflict before it happened they would be better to handle conflicts if and when they arise.

4   RESULTS

The effect of the changes in the CLP course from 2012 to 2013 will be analysed by comparing both the written Process Analysis at the end of each semester documenting the student teams' use and development of team work competencies and individual answers from the students to relevant exam questions taken from a written exam of the course.

4.1 Process Analysis 2012 versus 2013

As mentioned in section 1.3 the lecturer after the P1 period make a written comment to each of the teams process analysis about how things happened in their team and how to improve the performance in the next semester. There are no official marking of the process analysis because the focus of the commenting is to give feedback to the students with questions that might help them to reflect once more or deeper on specific aspects in the analysis.

To be able to see if there are changes in the level of the process analysis from year to year the author mark them anyhow using the Danish marking scale except for the very top and bottom mark. These unofficial marks were given when I was reading the process analysis and didn't have plans yet to write a paper about the experiment so I consider them unbiased of the investigation and useful to compare the two versions of process analysis.

Table 2. Unofficial marks of Process analysis from 2012 (21) and 2013 (26)

Mark	Designation	Eu Scale	2012	2013
10	Very good	B	14 %	15 %
7	Good	C	29 %	27 %
4	Fair	D	19 %	23 %
02	Adequate	E	19 %	19 %
00	Inadequate	Fx	19 %	15 %

The results in *Table 2.* show no significant differences between the two years so the quality of the documentation of team work skills and the team's ability to reflect on their experiences and suggest improvements for the next semester in the process analysis has neither improved nor worsened.

4.2 Exam in CLP course 2012 versus 2013

The CLP course is clustered with another course when examined. Both courses counts 50 % of the result and the students are given pass or non-passed based on their answers in a written 7 hour exam.

There are too few students from Software Engineering and Computer science who fail's the exam to see any significantly difference between 2012 and 2013 just by looking at the numbers from the clustered exam but it is possible to look deeper into the results of the specific questions from the exam and compare questions testing the student knowledge in some of the focus topics from section 1.4.

It is a big task to look into result from more the 300 individual exam's but since there are almost no differences between Software Engineering and Computer Science in the total exam results only the two cohorts of Computer Science students will be investigated when looking into the individual answers, reducing the numbers to 41 in 2012 and 40 in 2013.

The questions in the written exam changes from year to year, but both in 2012 and 2013 there were questions about time schedules and conflict handling where the level of the answers might be used to compare the student's knowledge about the subject. Each question could collect a maximum of either 10 or 20 points. The total amount of points for the clustered exam was 100 and the student should collect 60 point to pass. The average number of points for each of the two questions in focus is calculated both in 2012 and 2013 and converted to the percentage of the maximum number of points in *Table. 3* showing no significant difference for conflict handling but an improvement of 20% in the scores for time management.

Table 3. Exam score in specific questions 2012 and 2013

Year Question	Time Management	Conflict Handling
2012	76 %	74 %
2013	91 %	76 %

At the exam in 2013 the topic about team roles was also questioned and the average score was 68%.

5 DISCUSSION

The result from comparing the two different versions of the course in chapter 4 shows that the results from both the level of process analysis and the score in specific exam question is very alike. The only

significant difference is the score in the exam question about time management which is 20% higher in 2013 than in 2012. The two exam questions was not identical so the score is not measuring the exact same knowledge but although the result don't prove that the students in 2013 had a significant better knowledge about time management there is an indication that they are at least better to explain this knowledge in writing.

It is possible to look deeper into the exact content of the process analysis to investigate if the use of time management has improved from 2012 to 2013 as the results from the exam question might implicate. This is not the case. My experience tells me that many students, especially those studying IT don't think that they need overall time schedules and plan only on a weekly or daily basis when controlling their first big project (P1) but when they reflect in writing in the process analysis at the end of the semester they all acknowledge that they should have used time schedules and they suggest to do it in the next semester. The same pattern was revealed in the process analysis from both 2012 and 2013.

One way of explaining this result is that the ideas of letting each team experience the challenge and strength of planning (see 3.2) has enforced the students' knowledge and awareness about time management but not succeeded in inspiring the teams to make time schedules for their own projects when needed.

6   CONCLUSION

These papers has investigated the consequence s of reducing lecturing and use more time to activate students in exercises and reflections in a course offered to help the students develop their skills in cooperation, learning and project management. The results show that less lecturing doesn't decrease the student's skills in the subjects and more exercises and reflections don't improve the skills either.

As a teacher and researcher in a Problem Based Learning environment with 34 years of experience it is of no surprise that lecturing is not a very important part of the student learning process but I had expected that a higher level of activity exercises and reflection would both improve the student learning and the use of the knowledge to develop better skills in the team work with their projects.

Knowledge is tested at the exam and there is an indication that knowledge about time management has been improved. Skills are developed when doing and the process analysis is documenting the skills. The investigation of the process analysis shows that most teams practice Peer learning and manage to share the workload and handle conflicts if they arise but they hesitate to use time management in their first big project. In the continues development of the CLP course it will be interesting to try if it is possible to find a way to develop the students time management skills from the very beginning of their first big project.

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