

Collaboration and Peer Learning in Problem Based Learning

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1 INTRODUCTION

All Engineering Educations at Aalborg University uses Problem Based Learning as learning method on each semester where the students work in groups of 5-7 members on a 15 ECTS semester project supported by three 5 ECTS courses. An important aspect of the first semester of the educations is a course where the students get tools and tricks for good communication, collaboration, learning and project management (CLP).

Well-functioning collaboration in a student group is not only important for the overall outcome of the project but also for the individual student's learning of engineering skills used to develop the project. When working on the projects the students often work on parallel tasks in small subgroups or individually. The knowledge each of them achieve is supposed to be shared with the rest of the group to enhance everyone's total learning. This knowledge sharing is peer learning and a very important learning resource in the PBL setting of the projects at Aalborg University.

As William Damon [1] already pointed out in his position paper on Peer Education in 1984: "Through mutual feedback and debate, peers motivate one another to abandon misconceptions and search for better solutions" and "Collaboration between peers can provide a forum for discovery learning and can encourage creative thinking". This is what happens in those groups that succeed in collaborating and sharing their knowledge, but not all groups are equally successful in doing that.

It seems obvious that groups with good communication and collaboration who is working most of the time in their group room has a higher potential for peer learning

and a successful sharing of knowledge than groups struggling to communicate and collaborate and often doing most of the project work individually at home.

This paper will investigate this hypothesis focusing on how different students groups set up their collaboration and sharing of knowledge (peer learning) and how this influence their perceived learning outcome.

2 METHOD

As a case for the analysis, the education of Bachelor in IT and Informatics (BAIT) is chosen. The students on this education is quite diverse and the groups perform very different when it comes to collaboration and peer learning.

There are 74 first semester students in the program that started in the fall 2015. Experiments from previous years on the same study [2] has succeeded in activating most of the students in the CLP course (see 1) and using the skills achieved in their project work.

There are two types of written output from the students assessing collaboration and Peer Learning, namely:

- A group based process analysis reflecting what happened in their group, why it happened and how to improve the performance in the next project. The process analysis is a shared written document where each group member is supposed to have participated in the writing and review. If somebody don't agree in the analysis from the majority of the group this will usually be noticed in the document.
- Individual reflections on knowledge sharing and peer learning from the CLP course exam.

Analysing these data show how groups perform in collaboration and peer learning based on their own assessment. These assessments are compared with the actual marks for the members of each group, in order to see if there is coherence between them.

3 RESULTS AND DISCUSSION OF ANALYSIS OF WRITTEN OUTPUT

In the process analyses made by the semester groups one of the issues they are expected to analyse is the learning process of the group and how they shared the knowledge obtained by the project work (peer learning).

The 74 students had formed 12 groups and the process analysis of each group was analyzed with focus on peer learning to identify how the groups had succeeded in sharing knowledge both on a daily and weekly basis. This analysis showed:

- A. Six groups wrote about how they successfully shared the knowledge gained in each task of the project both in writing and oral discussions.
- B. Two groups did not address peer learning or knowledge sharing at all.
- C. Two groups wrote about helping each other solving exercises relevant for their project work in the courses, but did not mention anything about if and how they shared knowledge produced in the project tasks.
- D. Two groups wrote about having big disciplinary problems with members being late or not showing up. One of these groups did try to share knowledge but was not successful due to the lack of discipline. The other group did not even try to share knowledge.

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. The questions in the written exam changes from year to year, but in 2015 there was one of the questions that addressed peer learning: "How can you ensure that everyone learn from each other (peer learning) and share the knowledge you each have achieved through the project work?"

This question counted max. 10 points with 6 point being passing mark. Comparing with ECTS markings 10 points equaled A, 9 points B, 8 point C, 7 point D and 6 point E.

The average mark for each group is calculated and the results is shown in *Table 1*.

At the project exam each students is given an individual mark using the Danish seven step marking scale that can be translated to the ECTS scale. The individual personal marks is not public but it was allowed to use the average mark for each group in this paper when actual group identification is not possible. These marks is shown in *Table 1*. where the groups is named A1, A2, . . B1, . . etc. according to the results of the analysis of their process analysis.

Table 1. Average group marks from two exams.

Group characteristics according to their process analysis	Group	Mark Project Exam	Mark Course Exam	Distance of more than one mark
Groups successfully sharing knowledge both in writing and oral discussions	A1	B	B	
	A2	B	B↓	
	A3	B	D↓	!
	A4	B↓	C	
	A5	C	C↓	
	A6	C	E	!
Groups not addressing peer-learning or knowledge sharing at all	B1	C	C	
	B2	C	D	!
Groups not addressing peer-learning or knowledge sharing in projects but addressing helping each other in course exercises relevant for projects	C1	C↓	C	
	C2	C↓	B	!
Groups having big disciplinary problems with members being late or not showing up	D1	E	E	
	D2	E	E	

The average marks for both project exam and course exam presented in *Table 1*. is almost the same for each group except the four group with a mark for "Big distance".

Looking at the lower marks in the course exam for group A3, A6 and B2 it might be due to big differences in the course marks of the individual group members of each of the 3 groups.

The C2 group was one of the two groups that helped each other solving the exercises in the courses, but it was not all the members that participated every time. The members of the group did know how knowledge can be shared, and this gives good answers and marks in the course exam, but they were not very successful in doing it in practice in their project resulting in lower grades (C's and D's).

The analysis of the written outputs compared to the project exam marks indicates that the hypothesis is right. Four of the groups that shared project knowledge successful ended up with the highest marks and the two students groups that struggled with discipline and did not succeed in sharing knowledge ended up with the lowest marks. The six other groups all got close to a C as average grade with four of the groups writing in their process analysis that they practiced peer learning. The resting two groups did not mention anything about how they practiced learning and knowledge sharing but they might have done and just forgotten to explain it.

Although the results of this analysis of the student groups own written assessment of their cooperation about learning and knowledge sharing is in line with the hypothesis for most of the groups, there is five groups that didn't assess the issue of peer learning. Other groups was not specific about how they shared their knowledge, for example has only half of the groups stated if they worked on project tasks in small groups or individual nor where they did most of the work (at University or at home). It will therefore be interesting to conduct further investigation into the issue of peer learning and work ethics in the groups.

4 METHOD FOR FURTHER INVESTIGATION

The first analysis has been carried out after the end of the first semester and the students have formed new groups for the spring semester 2016. The students have also started on a new project. Therefore it is difficult to conduct further investigation in the groups behavior from the first semester.

Experience shows that groups who perform well, like each other and don't experience internal problems often continues as a group in the next semester and groups that have a lot of disciplinary problems or disagreements about work ethics and the content of the project often split up. So not surprisingly the three the groups that got the best grades (A1 – A3) continued as groups and so did also three of the groups in the middle (A6, B1 and B2). The four lowest graded groups and two of the others split up in two, three, four and even five different groups.

With this group formation, it is not possible to collect the missing information about the C and D groups from the first semester. The B groups who didn't comment on peer learning at all in their process analysis have stayed together and might continue to work with the project in the same way that they arranged their cooperation and knowledge sharing in the first semester. It is also possible to collect information about the continued behavior of the three best performing groups and it will be interesting to know how the new formatted groups arrange their cooperation and knowledge sharing.

To gain more information about the group cooperation and knowledge sharing an interview is made with each group following this interview guide:

1. How is your group cooperation organized on a weekly basis focusing the project?
2. How much time do you work in the group room compared to home?
3. How do you communicate when working at home?
4. How do you help each other in the courses (e.g. solving exercises)?
5. How do you share the knowledge collected in the tasks concerning the project?
6. How is the group spirit?
7. Do you socialize outside the university?

The interviews took place two month after the start of the spring semester when the groups were well established and the project work progressing. Each interview was conducted by the first author, and lasted app. 45 minutes. Notes were taken on site.

5 RESULTS FROM INTERVIEWS

In the spring semester, there is only 11 groups as a number of students dropped out during the first semester. The average number of students in each group was six. One group did not show up for the interview and in total 4 other group members from the remaining groups did not participate.

The answers to the seven questions was quite similar for some groups and for each question there were 3-5 different answers when looking across the groups:

1. Most of the groups are well organized with plans and several meetings every week. Some groups is not quite as well organized but meets every monday and plan the week. A single group worked more randomly, only planning when tasks are finished and only few days or a week ahead.
2. The groups were asked to estimate how many percentage of their project work during a week they were at the University and how many at home. Seven of the groups spend most time at university and three groups preferred to do most of the project tasks at home.
3. All groups except one used a closed group fb-chat every day, especially at home. Some also used Skype, team-chat etc.
4. All groups solved the exercises in a math course together. except one who only talked about eventually misunderstandings from the lecture. Three groups also solved exercises in the two other courses together and one group did it in some lessons. Two groups didn't only solve exercises together but also discussed the theory helping each other understanding difficulties.
5. All groups shared written documents on a group drive and read the documents when they were uploaded, except for one group where only some (a few) of the members read the documents. Eight of the groups did not only read the documents but also held meetings to explain and discuss the documents.
6. All groups except one described their group spirit as good or high. The last group found it a little difficult to talk together.
7. Three groups were socializing a lot outside University; sports, gaming, cinema, party, a beer. Three other group socialized sometimes (once or twice a month). One group had only one social event and the resting three groups did not socialize outside university at all.

Based on the limited numbers of different answers it is possible to establish an overview of similarities and differences between the 10 groups ordered according to organization and time spend at university. This is done in *Table 2*. leaving out question

3 and 7 where all answers were alike except for one group (V) on question 4 and one group (IV) on question 6.

In *Table 2*, the groups are labelled in roman numbers for the **Spring** semester and the corresponding group number from the **Autumn** semester used in *Table 1*, is also noted for those groups that continued. The new formed groups are labelled mix and the number of former groups involved. The order in the roman numbers in *Table 2*, is chosen to structure the groups according to similarities in their behaviour:

- Groups labelled I and II (seven groups) uses more than 2/3 of their working hours at University and the three groups labelled III, IV and V do most of the work individually at home.
- If question 1 is used for structuring label I and III are the six well organized groups that also socializes frequently outside university. Label II and IV are three organized groups and label V is the randomly organized group. None of these four groups socializes outside University.

Table 2. Overview of the groups answers to questions from 4.

Group S - A	Question 1 Organizasion of group	Question 2 Work at Uni/home	Question 4 Helping each other in courses	Question 5 Knowledge sharing	Question 7 Social activities
I.1 – A2	Well org.	70/30	All ex.+dif.	Read+talk	Sometimes
I.2 – A3	Well org.	80/20	Only math	Read+talk	Often
I.3 – A6	Well org.	70/30	All ex.	Read+talk	One party
I.4 – mix 3	Well org.	80/20	Only math	Read+talk	Often
I.5 – B1	Well org.	70/30	Math+½other	Read+talk	Sometimes
II.1 – mix 4	Organized	80/20	All ex.+dif.	Read+talk	No
II.2 – B2	Organized	70/30	Math in beg.	Only read	No
III – A1	Well org.	35/65	Only math	Read+talk	Often
IV – mix 2	Organized	50/50	Only dif.	Read+talk	Seldom
V – mix 3	Random	40/60	Only math	Some read	No

6 DISCUSSION OF INTERVIEWS

The reason for doing the interviews was to get more detailed knowledge about the behaviour of the different groups with focus on communication, collaboration, organization and knowledge sharing.

The three highest graded groups from the project exam in the autumn continued as groups in the spring semester (A1 – A3) and not surprisingly, they are all well organized and is sharing all knowledge in the project both reading and discussing all documents. New obtained knowledge is that they socializes outside university improving each group members knowledge about the other members and establishing friendship.

Former group A1 (now III) is one of the four groups that prefer to do most project tasks at home but although most of the “homework” is done individually this group swap tasks and review each others documents before the final review by the whole group. The group do not have any trouble with discipline and the time spend on university is used efficiently to plan and share project tasks. It is the only group working mostly at home that socializes outside university.

The two B groups from the first analysis did not write about knowledge sharing in the process analysis from the autumn semester, so there is no knowledge of what they did at that time. This semester B1 is well organized, share knowledge both reading and discussing documents and they socializes sometimes outside University. B2 is organized but not as much as B1 and the other label I groups. B2 share knowledge only by reading and do not socialize outside University.

The results obtained from the interviews shows that there are more similarities than differences in the answers and it is possible to make a reasonable classification of groups using three categories.

For each category an example of the answer to question 1: How is your group cooperation organized on a weekly basis focusing the project? is presented. The examples are the author’s translation of the notes taken at the interview from one group representing the category, with all group members being possible contributors’ to the total answer.

6.1 The well-organized group that shares knowledge and socialize (label I and III, totally 6 groups)

This group meets almost every day to discuss the project and its progress. The tasks are distributed both individual and sometimes in smaller groups. Although the group do most project work at the University (except one), each group member also do a lot project work at home, communicating regularly with the other members.

All knowledge gained in the project is shared both reading and discussing the documents produced. All group members attend all lectures. In math courses the members solve the exercises together and some groups (50%) also solve exercises in the other courses together.

The group spirit is high and the group members meets outside University more than twice a month for sports, gaming, cinema, party, a beer, etc.

Example 1: "We are very different and speaks loudly. We try to use each other's strengths and be honest with each other. This sometimes causes conflicts with different opinions about how things should be, but we solve them. All are active and tasks are distributed using both strengths and weaknesses that needs to be improved. Several tasks might start up involving two members and be terminated by two others. Most members are then a part of most tasks."

6.2 The organized group that shares most knowledge (label II and IV, 3 groups)

This group often uses Monday for planning project activities for the whole week. Specific tasks are distributed on an individual level and usually this work is done at home, communicating regularly with the other members. At University, the group uses the time to discuss the results of the performed tasks and the progress of the project.

All documents is shared and usually read by all members, but in some groups there might be a few members not reading all documents. If there is something a member do not understand they can ask and the author will try to explain. Not all attend all

lectures and they are not very good helping each other with exercises although they try to do it at least in math courses.

The group spirit is not as high as in a 6.1 group and there is a risk of a single group member not following the group rules (cooperation contract) which then frustrates the rest of the group and sometimes make it difficult to talk freely with each other. The group members do not socialize outside University.

Example 2: "We meet every Monday and make a weekly plan and work every day after the lecture, sometimes we assign each other homework. The big project tasks are divided in smaller tasks that can be made at home. Time at the University is mostly used to coordinate and cooperate the project and achieve common understanding for anything."

6.3 The unorganized group that do not communicate and share knowledge nor socialize neither at University or outside (label V, 1 group)

This group is not organized formally and only meet after lectures to "give each other homework". Then they go home and rest after the lecture. They do the individual homework with very little communication although they have a fb-chat, but it is seldom used.

They share the produced documents on Goggle Docs but it is only a few group members that read the documents and they do not discuss any documents except those that is criticised by their supervisor. There is only informal review of the documents but the group have blocked four days at the end of the project to do review together.

The group spirit is low and although the members can make fun and fool around sometimes at the University they are not mates and do not socialize neither at the university or outside.

Example 3: "We meet after each lecture and talk, might e.g. assign each other "homework" but then we need to rest and often go home, especially after math. We meet on Skype in weekends or when we do not have lectures. Sometimes we work here when it is easier, e.g. when programming. From time to time we agree on how and what to do and suppose we agree."

6.4 Why do the groups behave different?

Although the groups is formed by the students themselves the students in a specific group might have different expectations and preferences for cooperation, ambitions, workload, discipline, how much time to spend at the university and how to share knowledge with the other team members.

The three different group types corresponds well with different group behaviour seen at almost every study on first and second semesters. The number of unorganized group (6.3) will usually decrease as the students develop better teamwork skills and motivation or decide to drop out or change to another study. At the same time the number of well-structured and well-functioning groups (6.1) will increase due to the same reasons and enhanced by the fact that already well-functioning groups often continues to stay together for 2-4 semesters.

7 CONCLUSION

The results of the first analysis of written outputs showed coherence between active knowledge sharing and marks at the project exam for those groups that assessed knowledge sharing and peer learning.

The second analysis of interviews with the groups showed that the best performing groups from the autumn semester continued to share the knowledge gained and the new formed groups also share most of the achieved knowledge, except for the group labelled V (6.3).

If the group classification (6.1 - 6.3) based on the interviews is compared with the hypothesis the well-organized group type (6.1) should get the highest marks at the spring exam and the unorganized group (6.3) the lowest grades. At the end of June 2016 exam results will show if this is right or wrong.

If the hypothesis is strengthened this knowledge will be presented to the students of the new cohort starting in September. They will also be presented with the group classification so they can identify what kind of group they are and be more aware of the consequences in terms of learning and marks. It is interesting if this will influence their choices about how to organize the group, how to distribute the project tasks and where to do the work and how to share the obtained knowledge.

The experiment will be observed closely to investigate if the knowledge and awareness changes the behaviour of some of the groups and improve their learning outcome.

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