



## Problem-Based Learning (PBL): A context for collaborative learning at Aalborg University, Denmark

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### Abstract

This study involving six first year's Medialogy undergraduate students seeks to provide insights of the students' perspectives on learning in a collaborative group context, learning impact and reflection associated with the participations in a Problem-Based Learning (PBL) 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 beginning 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:** Aalborg PBL Model, collaborative learning, group learning strategies, impact of PBL learning, problem based learning, students' reflection.

### Introduction

Since 1974 Aalborg University (AAU) has utilizes the Aalborg PBL which is 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). 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 serves 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 supervised 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-centered and innovative pedagogies are gradually adapted in higher education institutions worldwide, the PBL model as practiced in AAU has different features since it emphasizes 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 importance to include student perspectives and learning process in the effort to improve the PBL practice in higher education. Faidley et al. (2000) and Holen (2000) agreed 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 it means to engage in constructivist learning activities need to be taken into considerations. Likewise, Ellis et al. (2008) emphasized not to assume 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 sheds 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 students 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.

## **Methodology**

### *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.

### *Participants*

Six undergraduate Mediaology 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) and they had never experience group learning or PBL in their previous education. Of six students, one is female and international.

### *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 study, the insights obtained during the first interview sessions are 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 audio taped 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.

### *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 analyzed using grounded theory 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 analysis report, document analysis techniques were used to analyze the data.

## **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 with 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.

### *Group learning strategy*

As a learning approach that emphasizes group work, discussion 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 white board 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 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 key features 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 is well-verse in sounds for computer program like creating, adding and mixing the sounds. So he always takes 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 reason 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 task 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, time table 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 agreements were 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 extent, the group agreement is used to clearly spell out the rules 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, if 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 used to plan the group activities according to the timeframe or weeks. Group of students clearly laid out what they should do 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 the entire group planning in their time table such as the whole plan, the different deadline for 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 used 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.*”

#### *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-themes; timetable, group members and group learning process. In planning, the groups' 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 taking 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 tolerable, open to criticism and gain mutual trusts. Here is 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. Concerning 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 these 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 “*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. Concerning 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. Consequently, 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, group members must establish an effective and collaborative group environment. A student (IV\_6) observed that each group members should “*keep 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 creates 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.

#### *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 mix the learning with our personal matter or make our project in a sluggish way, I also learn on how to stick to the plan that we had made before, and of 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 depends 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 communicate. 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 occurs when students learn from each other and correct the mistakes of other group members. The following excerpts confirmed the claimed:

“We (are) also very good at correcting and reading through each other’s tasks, so if someone has written something, I’m the one who normally corrects, and if there is anything missing, I’m the one who pinpoints 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’s point of view, and I didn’t think about writing 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 individually since every single decision is taken after a series of discussions and every group member is 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 discussed in the groups. Learning from group members and correcting group members’ mistakes 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 goals in PBL whereby students feel the ownership of what they have learned in the class. A student (IV\_3) explained that although “*we have quite different learning styles, but we still can cooperate and together we became a learning community within our group*”. Another student (IV\_5) internalized this collectively constructed knowledge and applied the learning in different contexts. This student further observed that he is able to transfer knowledge and skills acquired within the group to other learning environments “*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 contexts 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 involves 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 have 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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