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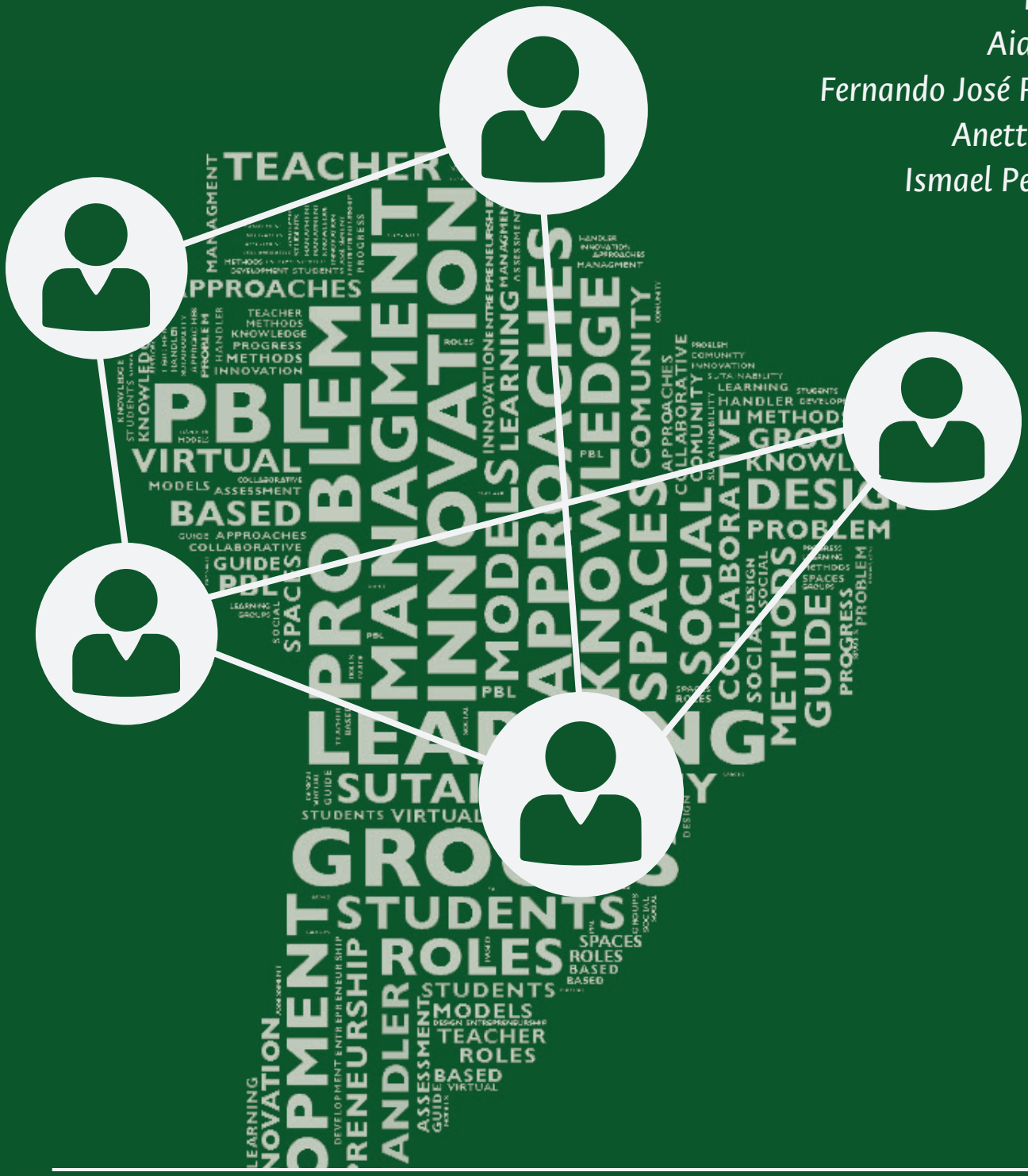

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Empowering students to co-construct the PBL environment

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Abstract

In this study we have analyzed students' reflections on institutionally defined Problem Based Learning (PBL) principles and discussed students' ability to actively conceptualise PBL principles. The study was carried out at the Faculty of Engineering and Science, Aalborg University in 2016, in the first year of the international Bachelor program of Media-technology. The purpose of the study was to facilitate students' identity formulation as self-directed learners in a PBL environment through enhancing their awareness of the principles that constitute this environment. In connection with the study newly enrolled students actively reflected on the PBL principles, made their own definition of PBL and, last but not least, used this PBL definition to analyze their learning process during the first project. The findings show that the principles of self-directed learning, business collaboration and the work with real life authentic problems were stressed by students as new aspects of PBL. When asked to point out the most positive characteristics about studying in a PBL environment, the students pointed to team work, meta-learning and self-directed learning, whereas less attention was given to the direct support provided by staff. When asked to point out the most challenging characteristics, approximately half of the students pointed to self-directed learning; even though this characteristic was seen as one of the most positive aspects of problem based learning, it was also one of the most challenging. In the process analysis, reflecting on the first PBL project, students document their ability to not only define PBL from their own perspective, but to also use the defined understanding of PBL to analyse their learning process and as a result refine their understanding of PBL.

Keywords: PBL principles, conceptual understanding, self-directed learning, meta-learning.

Type of contribution: Research paper.

1 Introduction

Problem Based Learning (PBL) is not a fixed concept; the conceptualisation of what we call PBL is very dependent on the different contextual settings as well as on the actors who attach meaning to the concept, at the conceptual as well as at the practical level. Not only staff but also students will give different meanings to the concept and will have different practices. These inner meanings and conceptual understandings will influence the learner's practice.

However, meanings and understandings of PBL often remain implicit in the move from the theoretical to the practical level. At the institutional level, some institutions explicitly formulate their PBL principles across faculties, but less attention has been given to how students interpret and shape their understandings of PBL based on these institutional formalised PBL principles. In this study we have focused on how students interpret the explicitly formulated PBL principles and whether they are capable of relating these principles

to their own study practice. We do this by letting students with limited experience with PBL move beyond being informed to actively and critically reflect on and discuss the PBL principles.

1.1 PBL principles

Some basic principles have to be in place under the headline of PBL. In Table 1 is shown the comparison made by Kolmos & de Graaff (2014) of the original learning principles at four of the universities that first applied PBL. The table shows similarities regarding the emphasis on problems and small groups. But placing the students in a group with a predefined problem does not seem to be enough, as there is also a strong emphasis on self-directed learning. With reference to Rogers' (1969: 162) perception of learning with relevance for students' own purpose, De Graaff et al (2016) have described self-directed learning as a transformative process which is characterized by active participatory processes involving "the whole person" and a significant amount of "doing".

Table 1: Original Learning Principles at four of the PBL Universities (Kolmos & de Graaff, 2014, p. 145)

McMaster and Maastricht Universities *Problem-based learning*	*Aalborg and Roskilde Universities* *Problem-based and project organised learning*
• Problems form the focus and stimulus for learning • Problems are the vehicle for development of problem-solving skills. • New information is acquired through self-directed learning. • Students-centred • Small students groups • Teachers are facilitators/guides	• Problem orientation • Interdisciplinary • Exemplary learning • Participant-directed learning • Teams or group work
Barrows, 1996	Illeris, 1976

As seen in the second column of Table 1, the PBL approach described by Illeris (1976) moves beyond the way to learn to focus on contents of learning, as it calls for interdisciplinary and exemplary learning contents. Whereas the interdisciplinary aspect of PBL points to more complex problems, exemplary learning stresses a more contextual perspective and the learning of transferable knowledge. Oscar Negt (1968) has been one of the most influential sources of inspiration to the Danish use of the principle of exemplarity, due to his work on 'Soziologische Phantasie and exemplarisches Lernen". As explained by Zeuner (2013: 149), the ambition for societal changes in such a conceptualisation of exemplarity is related to wider political, economic and global contexts.

Holgaard et al (2016) related contextualisation of problems and potential solutions to the problem design process pictured as the identification, the analysis and the formulation of a problem, as the problem analysis includes considerations to such wider contexts. Andersen and Heilesen (2015: 32) has furthermore explained the relation between the exemplary principle and project work in the following way:

"The exemplary principle may be implemented by different pedagogical strategies, for example, by requiring project reports to reflect on social, theoretical, or methodological issues, by requiring group members to

discuss the projects among themselves taking into consideration a broader scientific and social framework, or by committing the students to reflect on the relation between course content and their own project work."

Thereby PBL is not only a transformative process at the individual level; it is also a process, which is set out to have a broader social and even societal impact.

Aalborg University (AAU), Denmark is working from Problem Based Learning principles embracing exemplarity and contextual view on learning. Therefore, Aalborg University is seen as a suitable case to explore the way students co-construct the meaning of PBL and relate PBL principles to their educational practice. The next sub-section gives a more detailed description of the principles underlying the AAU PBL model.

1.2 The Aalborg University PBL principles

Aalborg University was founded in 1974 and has from the beginning been based on principles of problem orientation, project organisation and teamwork (see table 1). At the faculties, these principles were formulated in greater depth by domain specific researchers, e.g. engineering education researchers (see for example de Graaf and Kolmos, 2007).

In 2010 the university management started a development process to not only explicitly state the PBL principles but also explicate the responsibilities and activities of different actors in implementing these PBL principles. The process was initiated by hiring an external consultant with an "outside" view on the commonalities in the way PBL was practiced at institutional level (see Barge, 2010). During the following five years, the management explicitly formulated their commitment to embed PBL principles in all programmes and in the educational practice of all actors in all faculties, This process was supported by other institutionalisations, such as a cross-faculty PBL academy. In 2015 the folder "PBL Problem-Based Learning" describing the AAU PBL principles was published from the Rector's office stating that "*All educational activities at Aalborg University involve problem-based project work, which takes as its point of departure a set of principles that constitute the Aalborg model of Problem-Based Learning (PBL)*" (AAU, 2015:3). As a first basic principle it is stated that:

"The problem is the starting point directing the student's learning process. A problem can be both theoretical and practical. It must also be authentic and scientifically based. "Authenticity" implies that the problem is of relevance outside of academia. "Scientifically based" implies that the problem is comprehensible and may be analysed and solved, taking an interdisciplinary approach. " (AAU, 2015:4)

This first principle is followed by another five principles describing the problem based learning environment at AAU:

- Project organisation creates the framework of problem based learning
- Courses support the project work
- Cooperation is a driving force in problem-based project work
- The problem-based project work of the groups must be exemplary
- The students are responsible for their own learning achievements.

The description of the six principles is accompanied by descriptions of the educational *framework,* including an educational vision, curriculum and assessment, the educational *practice,* including students, academic

staff and external relations and the *support functions,* including resources, student organisation and programme administration and research in PBL.

In the PBL folder the formulated AAU PBL principles have been made explicit and they are to be anchored in written curricula as well as in the educational practice. The latter implies that not only staff but also students are important stakeholders in appropriating the PBL principles and translating them into study practice. This leads us on to the two research questions explored in this study:

- *How do newly enrolled students construct meanings and understandings of the PBL-principles?*
- *How do these meanings and understandings influence their study practice and learning processes?*

In the next sub-section the methodology applied in the study is described.

1.3 Methodology

This study is based on the experiment of getting newly enrolled students to actively reflect on the AAU PBL principles in relation to their study. The students in the experiment are first year Media-technology students doing the first project, the so-called P0 project, which has a duration of 5 ECTS. It runs from the first day, in parallel with courses, and students work in project groups of up to 7 students. The groups have about 25 days to do the project and document their findings in a report and their reflections regarding project management, collaboration and learning in a process analysis report.

The students come from different cultural backgrounds. Furthermore, the group of students are very diverse in terms of their prior experiences with PBL – whereas some have had no experience, others have worked on light scale problem based learning projects in small groups in high school.

The experiment took place as a five steps process.

First, students had a short lecture introducing the PBL principles. This happened at the first day of study and both PBL and Media-technology researchers was present at the lecture, to combine PBL principles with examples from the disciplinary field.

Second, during the first week, the 99 students were encouraged to read the folder about the AAU PBL principles individually at home, and to fill out a note-sheet reflecting (in writing) on the following 5 open questions:

- Insights from reading the folder that add to your prior understanding of PBL
- Examples of how the PBL principles relate to your prior studies
- Any principle you find hard to grasp – or lack concrete examples
- Three points you consider to be the most positive about working in a PBL environment
- Three points you consider to be the most challenging when you are about to work in a PBL environment.

Apart from being a part of the experiment on PBL principles, this activity also aimed at enhancing students' skills in note taking in connection with reading of scientific literature. They were encouraged to share their note-sheets on the learning management system Moodle. A total of 59 students out of the 99 shared their note-sheets on Moodle.

Third, at the end of the first week, students were attending a two hour workshop facilitated by a PBL researcher. Students were asked to bring their note-sheets on PBL principles and they entered into dialog in their project groups to make a joint conceptual map of PBL and a shared definition of PBL.

Fourth, students applied their PBL understanding in practice during their project work. They were encouraged to align their study activities with their understanding of PBL and note down study activities in a logbook.

Fifth, towards the end of the P0 project, students had a lecture and consultation from PBL staff to support them in reflection on their learning process and in writing their process analysis report. In this connection students were asked to reflect on the alignment between their original definition of PBL and their study practices by using this definition to reflect on the way the project group had worked and learned during their first project.

The data analysis has included content analysis of:

1) Note-sheets (59 sheets) handed in by individual students in step 2, describing students' reflection on the conceptualisation of PBL in the beginning of the study.
2) Written process analysis reports handed in by 14 groups in step 5, containing students' reflection on PBL practice during the P0 project period.

The note-sheets have been coded in relation to the type of PBL principles they relate to; and specific quotes are added to explain students' elaborations on their choices. The process analysis has been analysed with focus on the way students relate their understanding of PBL to their study practice.

2 Students' initial reflections on PBL principles

In the following, the findings based on students' individual reflections on the PBL principles in the beginning of the study will be presented. The findings are based on content analysis of the 59 note-sheets handed in by students.

2.1 Insights adding to prior understanding of PBL

The findings show that the emphasis on self-directed learning, the business collaboration and the work with real life authentic problems were stressed as main new insights on PBL at Aalborg University.

The emphasis on self-directed learning surprised many students, as 12 out of the 59 students explicitly referred to this as adding to their prior understanding of PBL. In relation to self-directed learning one of the students explains:

"After reading that folder I've realised that PBL is not only about group work and projects but also acquisition of knowledge in theoretical and more important, practical way. Little did I know that PBL will give me so much freedom of learning on my own or in project group. Now I'm aware that I'm the only responsible for my studies and University staff is here not to set out the only possible path which I will have to follow but support me and my studies." (Student nr. 1)

Several students also touch upon the emphasis on real life problems and what Holgaard et al (2016) have termed problem design – to identify, analyse and formulate a problem based on a real life context. One of the students explains:

"It's all about improving the students' skills regarding identifying problems, analyzing them and then solving them. It is especially important that the students reflect about their work, and analyze it critically so that adjustments can be made to the project." (Student nr. 3).

Furthermore, some students were surprised that the problem is the starting point directing the student's learning process" (e.g. student nr. 19, 40, 53) and furthermore one student (nr. 34) explicitly noted the multiple definitions of a problem in PBL, referring to the folder stressing that a problem can be both theoretical and/or practical. One of the students furthermore relates the problem design to the self-directed learning aspect of PBL (Student nr. 48):

"The foundation of this project is a problem framed in the contemporary time and space. Therefore, the students are supposed to formulate the problem, find the steps to solve it and present the final results as a solution to it that could be implemented in real life."

In total, 14 out of the 59 students in some way referred to the problem design process as a new insight on the Aalborg PBL model.

Furthermore, 20 out of 59 students stated that the outlined extent of interaction with external partners during project work was a new insight, adding to their prior understanding of PBL. This seems to confirm a traditional belief of an existing divide between academia and business, held by students even when entering a PBL environment. As an example, here is a typical response to the question of new insights on PBL concerning external collaboration (Student 11):

"The influence and possibilities of external relations. ("supports the contact between university staff, students and external organisations ") It makes PBL seem more real and relevant. I did not have this kind of understanding before I read this."

Overall, students expressed that the opportunity to cooperate with companies about the solution of an actual problem in their projects was motivating.

2.2 Examples of PBL in prior studies

When students were asked to note examples of how the PBL principles related to their prior studies, it was notable that students had very different levels of experience with a PBL environment. From no PBL experience, due to what student nr. 44 characterised as having been through "a fixed educational line to follow" to having experienced a "combination of different courses into a bigger project" (Student no. 5). In this case, the connotation typically refers to assignments, subjects or topics and a theoretical approach to problem solving. Student 1 explains:

"In my high school, I had a lot of group work activities such as small projects or workshops. I had possibility to work with some kind of problems but usually we were focused on the theoretical way of solving them and hardly ever they were "real".

There are also examples of smaller but rather similar types of projects in groups with a real-life problem as starting point. Especially students, which explicitly refer to high school experiences at the Danish technical high schools, present similar experiences to a PBL environment. Some students also stress that the folder express somewhat more (Student nr. 18):

"For my prior studies PBL has not been a huge part of that. We have experienced to work with real life problems and working in groups to find a solution. However, the model of our studying was nothing like PBL"

This underlines the variation of PBL – a relatively mature observation by a 1. semester student.

2.3 Principles which were hard to grasp

Most students found that the PBL principles as such were relatively easy to grasp after having had the introduction and reading session and as expressed by one student "pretty straight forward and/or self-explanatory" (Student nr. 24). Some of the students noted however that the whole perception of how PBL would be in general and in practice was hard to grasp:

"Not really. Just the general use. I do however think that this understand will be something that you get slowly, as you are using the PBL learning system" (Student nr. 5).

Furthermore, the following three principles were noted as hard to grasp by more than one student: i) The principle of exemplarity, ii) the way to approach the problem and iii) how exactly the interaction with external parties will be.

2.4 Three points being the most positive about PBL

Students had been asked to read the fourth paragraph on Students in the PBL folder (AAU, 2015:15) focusing on students' engagement in project work in AAU. This paragraph describes the 11 types of student engagement listed in table 2, together with the number of students stressing the corresponding type of engagement as most positive in regard to PBL. Students could mark up to three points in the list.

As seen in table 2, point number 7 "support one another in their academic work and contribute to a strong culture of cooperation" is the item, which most students found positive about studying in the PBL environment. Thereby, the most positive aspect of PBL is related to team work and the possibility to be a part of a team and offer mutual support. As some of the students explain:

"You are never alone and people help you. There are people with different mind-sets, so it provides wide knowledge. It makes it possible to see the problem from different angles." (Student nr. 16).

"It is great because you can get to meet and work with a lot of new people, and at the same time get new friends" (Student nr. 42).

Students also find it positive that they are to develop strategies for project cooperation, project organisation and management of learning (point no. 4). This can be interpreted as a clear motivation towards developing process-competences, including meta-learning competences to improve their own capability to learn. Only few students elaborate on their choice of this item, and for the few who do, the considerations are that it can be helpful in future projects or in future workplaces.

Last but not least, 26 out of 59 students have pointed towards item nr. 8 as one of the most positive aspects of PBL. The point of being free to manage one's own project work within the framework of the project module relates closely to the principle of self-directed learning. Some of the students who elaborate on their choice share the following argumentations:

"It's nice also having to decide in which time frames you work, as it gives you more responsibility as well as discipline when it comes to working in a professional manner." (Student nr. 12)

"Success from when you are finally on the right track" (Student nr. 21)

"It gives the student freedom to work with something they find interesting, since it's not fixed what should be done" (Student nr. 27).

"You have to take care of yourself and your group, solve problems together, and deliver." (Student nr. 39)

Table 2: Most positive points about working in a PBL environment (N=59). Student engagement refers to the list in Paragraph 4 (AAU, 2015). Top three marked with bold.

Number	Type of student engagement:	Number of students referring to this point out of the three most positive aspects of PBL (N=59)
1	receive an early introduction to the Aalborg PBL model and the reasons for its application	8
2	are supported in their efforts to integrate the problem-based, project-oriented approach in their academic work	13
3	are supported in successfully addressing any conflicts that arise in their work	9
4	**develop, throughout their studies, strategies for project cooperation as well as project organisation and the management of learning processes**	**26**
5	are motivated and take responsibility for implementing the problem-based approach in their studies	9
6	are motivated to create synergies between different cooperation cultures by collaborating with external partners and engage in interdisciplinary learning environments	12
7	**support one another in their academic work and contribute to a strong culture of cooperation in their studies**	**31**
8	**are free to manage their own project work within the framework of the project module**	**26**
9	will have the opportunity to participate actively in the evaluation of the study programmes	6
10	demonstrate commitment as regards improvements, critical analysis and constructive feedback	7
11	take part in curricular development through systematic evaluations and study board participation	3

In sum, when asked to mention the items that students found most positive about working in a PBL environment, the following three types of engagement were mentioned: team spirit (item nr. 7, 31 students), meta-learning (item nr. 4, 26 students and self-directed learning (item nr. 8, 26 students). An interesting observation is that students paid less attention to the support provided by staff. Thus, the

students practice self-directed learning in the PBL environment, and they express agency in knowledge creation and application, rather than act as passive receivers of knowledge transmission.

2.5 Three points being the most challenging about PBL

Based on the same list of 11 types of student engagement, students were asked to consider the most challenging points of being in a PBL environment. Table 3 outlines the number of students stressing specific points about PBL as challenging (up to 3 points could be selected).

Table 3: Most challenging points about working in a PBL environment (N=59). Student engagement refers to the list in Paragraph 4 (AAU, 2015). Top three marked with bold.

Number	Type of student engagement:	Number of students referring to this point out of the three most important (N=59)
1	receive an early introduction to the Aalborg PBL model and the reasons for its application	7
2	are supported in their efforts to integrate the problem-based, project-oriented approach in their academic work	2
3	are supported in successfully addressing any conflicts that arise in their work	6
4	develop, throughout their studies, strategies for project cooperation as well as project organisation and the management of learning processes	9
5	**are motivated and take responsibility for implementing the problem-based approach in their studies**	**11**
6	**are motivated to create synergies between different cooperation cultures by collaborating with external partners and engage in interdisciplinary learning environments**	**15**
7	support one another in their academic work and contribute to a strong culture of cooperation in their studies	3
8	**are free to manage their own project work within the framework of the project module**	**30**
9	will have the opportunity to participate actively in the evaluation of the study programmes	4
10	demonstrate commitment as regards improvements, critical analysis and constructive feedback	8
11	take part in curricular development through systematic evaluations and study board participation	7

As can be seen in table 3, 30 out of 59 students pointed to item 8, self-directed learning, as one of the most challenging aspects of working in a PBL environment. Thus, while students appreciate the freedom presented by self-directed learning they are also aware that this freedom comes with the responsibility for

own learning which constitutes a challenge. The below quotes from some of the students, who have elaborated on their choice of item 8, express their concerns:

"We have been given a great freedom of work on our projects, what can cause the risk of making wrong steps and mistakes during the whole process of making a project and also it can effect on our problem understanding and exam results." (Student nr. 1)

"To decide our own workflow can be a gift as much as it can be a curse." (Student nr. 23)

"Manage your own project. It's challenging because it can be easy to get side-tracked and distracted" (Student nr. 25).

"No direct indication of what to do and when to do the assignments, projects etc." (Student nr. 28).

"To learn how important it is to hand in or deliver work at the time, and manage your time right on the projects." (Student nr. 42).

"Free to manage our project work within the framework of the project module. This is a point that I think will be a bit hard for me to get used to, because it's a completely new concept to me and I'm still getting the hang of it." (Student nr. 53)

Other challenges pointed out by students are to create synergy in intercultural collaboration (item 6, 15 students) and to be motivated and take responsibility for implementing PBL in their study (item 5, 11 students). However, the main challenge is – beyond comparison – the challenge of self-directed learning.

3 PBL reflections at the end of the first project

The above reflections delivered by students during the first week of their study in an extensive PBL environment like the one at Aalborg University shows that students in fact are capable of reflecting on the learning model in a rather sophisticated way. However, in the constructivist spirit of PBL, student was asked to present their own definition of PBL based on their individual reflection and a facilitated concept mapping session. By the end of this first P0 project, carried out in groups of 6 – 7 students, students are obliged to hand in for assessment a group process analysis report, where PBL is used as the framework for analysis.

One group (A411, 2016) presented their initial definition of PBL, constructed in the concept mapping workshop (step 3), as:

"Our definition of "Problem Based Learning" is: Creatively solving real-life problems in collaboration with others, as a group"

However after working in a PBL environment during their first project, they found it necessary to revise this definition:

"*Fundamentally, PBL is a way to approach a problem. However, in our first description, we thought that PBL was just a way to find a solution. Having completed P0 we have learned that PBL is also learning how to communicate as a group, how to work together, research together, hypothesize a problem etc. The meaning of PBL is not to find a solution, but to figure out how to find it, and learn while doing it*".

It can be questioned, whether this kind of learning experience would have taken place, if the initial PBL definition had been corrected instead of being accepted by staff during the first week of study. On the

other hand, the students also recognise the scaffolding they have received to reach to this conclusion (A411, 2016):

"It is possible to discuss whether we, as students at AAU, are responsible for our own learning, because of the guidance P0 contains. As we get more comfortable with PBL, we will most likely start taking more responsibility for our own learning."

More groups discussed the principle of self-directed learning. Here is a statement from group A409 (A409, 2016)*:*

"In reflecting on the PBL principles, our group strongly emphasizes the freedom related with working project oriented. As it is with university, we are responsible for our own education, and this principle of learning comes even more to mind in PBL as we will not only be responsible for our own education, but others too".

This quote adds a social dimension to the concept of self-directed learning, and together with students attention to the mutual support from peers as expressed above, it also raises attention to the social formation of the "team-worker".

Another important point about learning that stands out in reading about the students' experiences in a self-directed learning environment, is that making mistakes is considered to be a learning condition more than an obstacle, as one of the groups wrote: *"We learned that making mistakes early is better than making them late"* (A412, 2016).

The reflections in the process analyses reports also showed evidence of the challenges already predicted when entering the PBL environment in relation to self-directed learning (A402, 2016):

"*Making sure that we were on the right track was a hassle throughout the whole project, we had a lot of doubts whether what we did was right or wrong. This is going to be a real challenge in all our projects, but our main focus should be to remain true to our original idea/concept that our supervisor has verified, instead of loosing our focus a lot. Staying true to PBL through managing the project, is staying true to our definition."*

So even though most of the students found that the principles of PBL were easy to grasp, they also had to acknowledge that these principles seemed harder to manage in practice. However, as noted by group A402 (2016): *"Analysing our work with PBL can be very difficult, using our own definition as we understand it made it easier"*

4 Conclusion

In this study we have analyzed students' reflections on institutionally defined PBL principles and discussed students' ability to be active players in the way PBL is conceptualized in the educational practice. As the case, Aalborg University, Denmark was chosen due to the explicitly formulated PBL principles and the profound PBL environment. The study was carried out in 2016 at the Faculty of Engineering and Science in the first year of the international bachelor program of Media-technology. The experiment has been to make newly enrolled students actively reflect on the PBL principles, to make their own definition of PBL and last but not least to use this PBL definition as a framework of analysis of the learning process after the first project, which is a pilot project with a duration of 3 weeks.

The findings show that the emphasis on self-directed learning, business collaboration and the work with real life authentic problems were stressed as main new aspects of PBL when entering the PBL environment at Aalborg University. When asked to point out up to three points that students found most positive about working in a PBL environment, the most appealing for students in the PBL environment were team work, development of process competences, including meta-learning and self-directed learning, whereas less attention was paid to the support provided by staff. Thus, the students practice self-directed learning in the PBL environment, and they express agency in knowledge creation and application, rather than act as passive receivers of knowledge transmission.

When asked to point out up to three points that students found most challenging about working in a PBL environment more than half of the students pointed to the self-directed learning aspect, a fact that demonstrates that even though students appreciate the opportunity for self-directed learning, it was also seen as one of the most challenging aspects. Other challenges attracting high attention was the challenge of creating synergy in intercultural collaboration and to maintain the motivation to take responsibility to implement PBL in the line of study.

Besides being of research interest, the results of this study about students' reflections on the PBL principles were valuable as a guide for the teachers to enhance students' PBL competences. The lecturer could use the identified challenges, addressed by the students themselves, as a motivator and a guide for the course material presented and emphasised.

In the process analysis report from student groups, reflecting on their first PBL project, students document their ability to not only define PBL from their own perspective, but also to use the PBL framework to analyze their working and learning processes and as a result re-fine their understanding of PBL. Making the students reflect on PBL principles and make their own definition of PBL is one way to let students co-construct the PBL environment, not only in practice but also at the conceptual level.

Such co-construction processes can be facilitated in many ways, but this study shows that the students are indeed capable of participating in conceptual co-construction of PBL principles, moving from individual prior understandings of PBL to added new insights to a shared and explicitly formulated understanding in the project groups. In this process the understanding of PBL becomes more concrete and something that the students feel that they need to be true to. In this way, the PBL principles are transformed from being an institutional, top-down obligation to becoming a platform for students' learning, helping them create awareness about and actively reflect on the learning environment they are entering.

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