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FLIPPED LEARNING IN A PBL ENVIRONMENT – AN EXPLORATIVE CASE STUDY ON MOTIVATION

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Abstract

This paper explores and presents some preliminary findings of implementing a flipped learning approach into the Aalborg University Problem-Based Learning environment. An analysis of the learning theoretical framework of the flipped learning approach in a Problem-Based Learning environment is carried out and this points at some structural concerns for motivating the students. Drawing on scaffolding and self-determination theory a new semester structure of a flipped and integrated semester is implemented at a 4th semester BSc program in Medialogy. The experiment, and an explorative case study, were conducted as part of a three-year research project called “Future directions for Problem-Based Learning in a digital age” carried out at Aalborg University, Copenhagen, Denmark. Preliminary findings on the students’ learning experience being part of this new flipped and integrated semester concept are presented and discussed.

Keywords: Flipped Learning, Integrating courses and projects, Motivation, Learning environment

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1. Introduction

Many colleges and universities have embraced flipped learning methods, as they provide opportunities for increased student interaction and deeper engagement with the material important for students' learning processes (Johnson, Adams Becker, Estrada, & Freeman, 2015). Flipped learning appears to be particularly well suited to engineering education, because of its potential to combine theories once thought to be incompatible, with active and problem-based learning (PBL) activities based on a constructivist ideology and instructional lectures (Karabulut-Ilgü, Jaramillo Chérrez, & Jähren, 2018).

There have been several studies of courses using *flipped classroom*, *flipped learning*, and *blended learning* approaches. Teachers and students respectively have different experiences, which vary with regards to structure, learning outcome and (time) resources needed (Triantafyllou, Busk Kofoed, Purwins, & Timcenko, 2016; Bertel & Svarre Kristensen, 2018). Literature reviews and studies on how new 'flipped' models function, show that the number of publications on this topic has increased enormously from 2004 to 2017 (Karabulut-Ilgü et al., 2018). However, learning theories connected to the new pedagogical strategies are still very much needed (Abeysekera & Dawson, 2015). This also includes definitions of the words such as flipped classroom, flipped learning and blended learning, which seem to be used interchangeably.

Since the inception of Aalborg University in 1976, the Aalborg PBL model (Askehave, Prehn, Pedersen, & Pedersen, 2015) has been continuously refined to align with the developments and expectations of the candidates, meaning the PBL model has undergone several changes. However, in 2011, a forced change put pressure on the PBL scope (Hüttel & Gnaur 2017), as all courses would require a stand-alone examination format, while students' semester-projects would be evaluated through team-based project exams. This change had a huge impact on both courses and students' semester-projects, as well as the semester structure. A new strategy was needed for the well-known AAU PBL model. In 2015 and 2016, approximately 30 small, local PBL projects were launched and funded by AAU. Several experimented with flipped classroom or similar approaches. Furthermore, AAU funded a 3-year research project *'Future Directions for Problem Based Learning in a Digital Age'* (Pblfuture.aau.dk).

As part of forming the future directions of PBL practice at AAU, one research group specifically focused on the flipped learning approach. In spring 2019, the group experimented with a new concept; a flipped and integrated semester, where all courses on a 4th semester at the 'Medialogy' BSc programme were to be flipped, and courses and project would be integrated (Kofoed, Svarre Kristensen, Andreasen, Bruun-Pedersen, & Høeg, 2018). The

motivation for this experiment was based on empirical data from former 4th semester students, stating that integration would be an improvement for the courses, and that the new course structure gave them less time for project work (Kofoed et al., 2018).

1.1. Problem statement

Research has shown that applying the flipped learning approach needs extra focus on students' motivation (Bertel & Svarre Kristensen, 2018). Students are highly motivated when working with the projects, but motivation problems occur in the courses (Svarre Kristensen, Kofoed, Andreasen, & Bruun-Pedersen, 2018). So, can an integrated pedagogic approach, using flipped learning, support students' motivation and learning outcome?

1.2. Research question

In this paper we wish to explore a theoretical framework to understand 1) why motivational problems occur when applying the flipped learning approach in the AAU PBL environment, and 2) how a flipped and integrated learning approach may be experienced by the students and how will it influence students' motivation, workload and learning outcome.

1.3. Purpose of the study

The engineering education at 4th semester of Medialogy in Aalborg University Copenhagen consists of three 5 ECTS courses and a 15 ECTS semester project. The semester theme framing the academic direction of the 4th semester is '*Sound Computing and Sensor Technology*'. The three courses consolidating the theme are Audio Processing (AP), Physical Interface Design (PID), and Design and Analysis of Experiments (DAE). Compared to previous semesters' course curricula, these rely more on math and programming. Internal AAU data shows that many students fail the ordinary course exams, and empirical survey data show that students who pass generally consider 4th semester as a difficult semester (Kofoed et al., 2018). In 2018, 62 students failed 75 ordinary exam attempts across the three courses (AP:35, PID:28, DEA:12). Changing the teaching practice and applying the flipped learning approach throughout the semester, could be a way for improving students' learning outcome. The purpose of this paper is to examine the structural and motivational concerns, when applying the flipped learning approach into this 4th semester of Medialogy and to present some of the preliminary findings of how the intervention effected the students' learning processes.

2. Methods and Theoretical Reflections

The background for the methodological choices is the theoretical reflection described in the following. We have used an explorative case study approach (Stebbins, 2001; Remenyi, 2013) in combination with a descriptive, mixed-method study (Stake, 1995; Yin, 2008), to investigate students' experiences of their 4th semester learning process. In this paper, our focus is students' learning processes; learning outcome, workload, difficulty with courses, and level of integration of courses and students' projects. To follow the learning process, we made 2 status questionnaires, asking students about their experiences of the three courses and their project work. Those aspects were reflected in the survey questions, which had space for qualitative explanations to supplement the quantitative answers. The two surveys were conducted on 26 February and 3 April, 2019 which were both answered by 38 students out of 59 students attending the 4th semester.

2.1. *A theoretical understanding of applying a flipped learning approach in a PBL environment*

From the pedagogically theoretical perspective of Jensen, Kummer and Godoy (2015), a flipped and integrated semester concept in a PBL environment is a good combination. Both theories are heavily anchored in active learning, and evidence shows that active participation leads to improved learning (Jensen et al., 2015), whereas passive learning has been shown to have a negative impact on performance (Hackmann & Holmboe, 2014). Lage, Platt and Treglia (2000), considered one of the pioneers, defined a flipped (or inverted) classroom as "*Inverting the classroom means that events that have traditionally taken place inside the classroom now are taking place outside the classroom and vice versa*" (Lage et al., 2000). However, the meaning of 'flipped classroom' and 'flipped learning' concepts is not exactly the same. We concur with Hackmann and Holmboe (2014) to separating the two concepts, so that the former concerns the structure and framework of teaching, while the latter concerns the processes and learning. The flipped learning approach thereby removes the traditional and transmissive lecture, replacing it with active in-class activities, such as peer learning, and problem solving, along with a special pedagogical approach for the out of class activities (Hackmann & Holmboe, 2014). PBL is also based on active learning, and the importance of activating the students in problem solving processes with real world problems.

2.2. *Applying the Flipped learning approach in to the AAU PBL structure*

PBL at Aalborg University is grounded in many different theories, covering both cognitive learning approaches, social learning, motivation theory, and social psychologies,

where all the theories have to be understood as coupled together (Kolmos, Fink, & Krogh, 2004). The learning theories are integrated in the *AAU PBL principles* (Askehave et al., 2015), which guide the teaching praxis at the university.

AAU PBL principles:

- Project organization 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
- Students are responsible for their own learning achievements (Askehave et al., 2015)

The principles cover three learning dimensions: 1) the problem, 2) the content and 3) the team. When organizing learning around students chosen *problem*, it is a central principle to establish autonomy. Problems have to be placed in a context, and have to build on students' previous experience, from both professional knowledge and knowledge of PBL principles. This is also an important source to establish motivation, as students formulate their problems themselves, based on own experience. A deep understanding of the *content* related to problem solving has great importance because it cultivates and enables students to transfer knowledge, theory and methods to new areas. The *team*-based learning is built on the principles of social learning and learning in groups. Student-centered and self-directed learning becomes important, for instance in the case of social learning (Kolmos et al., 2004).

The AAU PBL model frames the pedagogical teaching practice by supporting the three learning dimensions. When applying the flipped learning approach to this structural and pedagogical approach, focus is often placed more on moving teaching activities in time and space, rather than focusing on increasing engagement, autonomy and being student-centered (Abeysekera & Dawson, 2015). The extra focus on how to motivate students to do more (e.g. self-studying) has to be addressed, as it is necessary for more time to be spent on active learning in-class. In the 4th semester Medialogy experiment from spring 2019, the new flipped and integrated semester was designed to address this motivational concern and developed based on the self-determination theory (Ryan & Deci, 2000). The basic cognitive needs of being motivated had to be addressed and this could be done in the creation of not just a flipped semester but also an integrated semester where the integration should support students' motivation in courses.

2.3. Motivation and Self-determination theory

According to self-determination theory (Ryan & Deci, 2000), there are strong connections between intrinsic motivation and satisfying the need for autonomy, competence

development and relatedness. However, people will only be intrinsically motivated to carry out activities that are interesting to themselves, have the appeal of novelty, and pose a challenge that fits their individual zone of proximal development (Vygotsky, 1978). Cole, Field and Harris (2004) define motivation as “the willingness to attend and learn material in a development program” (p. 67). Motivation and engagement are thereby focused on the amount of the effort placed in learning activities, which has an impact on the learning outcome. 'Study intensity' refers to the total time the students use on their studies and is considered an important indicator for motivation and learning (EVA, 2016). Meanwhile, working with motivation and self-determination within teaching is a broader concept. Since 1985, when they introduced the self-determination theory (SDT), Deci and Ryan have emphasised motivation in educational contexts. They state that humans have three basic cognitive needs, that are universally applicable; the need for competence, autonomy, and relatedness. Students need to feel competent, meaning mastering the knowledge and skills needed in a learning context. They need to feel in control and independent. Managing students to ensure that they have autonomy in a learning situation is important. And last but not least, students need to have a sense of relatedness, which, for instance, is the feeling of being part of a group (Ryan & Deci, 2000).

When examining the motivational and structural concerns of applying the flipped learning approach into an AAU PBL environment, some dilemmas are bound to occur. In courses, developing the needed competences within the curriculum content is pivotal, but the extra challenge is on learning the content out of class. In this case, relatedness is crucial, when homework leads to creating a more interactive learning environment in the classroom (doing learning activities with fellow students and course teachers).

Supporting students' feeling of autonomy can also be very difficult, when the courses have a very strict curriculum content. While most courses do not provide many chances for student independence to mold their work in a self-determined (motivating) direction, the semester project (running parallel with the courses) provide this to students quite a lot, as themes can be angled to include topics or contexts of the students' choosing. Integrating courses and projects should thereby help students to be motivated, when courses allow activities that relate to self-determined and defined problems.

3. Findings

In the following, we look at some preliminary findings from the experimental approach to flipping and integrating the entire 4th semester, and see how the concepts worked in practice.

3.1. Learning outcome and workload

The flipped and integrated semester, as an experiment, is on its first iteration, and has been run only once (yet) at the 4th semester of Medialogy (spring 2019). To qualify as both a flipping and integrating approach, many changes were necessary, for example, in transitioning from a traditional teaching approach to the flipped learning approach. And not all have run without obstacles, such as with the development of the integration strategy, which has suffered from communication problems within the teaching group (Svarre Kristensen, Kofoed, Andreasen, & Bruun-Pedersen, 2019). Despite these hurdles, from 75 students failing the ordinary course exams in 2018, the number fell to 57 in 2019 after the flipped and integrated semester. No firm conclusions can yet be drawn on this, as more iterations are needed to see a tendency. Figure 1 shows students' self-evaluation ratings of their perceived learning outcome, between two surveys.

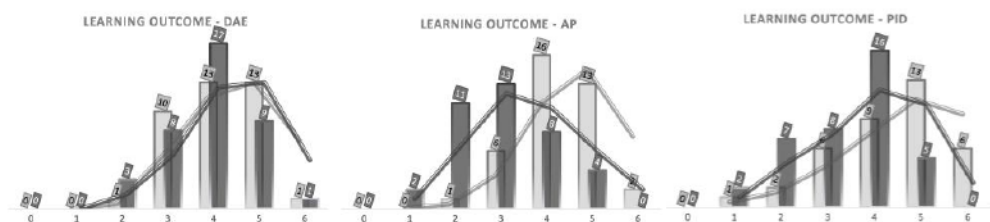


Figure 1. Students self-evaluated statement of the level of learning of the 4th semester courses. Evaluated from 0-6, where 0 is very low learning outcome and 6 is very high. The dark gray color shows results from survey 2 (April), both when looking at bars and the trendline. The light gray color shows the results from survey 1 (February), both when looking at bars and the trendline

Figure 1 suggests a stable development in the self-assessment of students' learning outcome at the DAE course, while there is a slight decline in learning outcome for both AP and PID. As stated previously, the DAE course has, before this experiment already utilized the flipped learning approach for about four years, and has already refined the flipped teaching approach. This may explain the stable learning outcome self-assessment. The decrease of learning outcome for AP and PID, can be a sign that teachers have not yet mastered their new pedagogical challenges fully, and that issues in the learning environment have developed into problems for the students' learning outcome.

Furthermore, we also see that the workload connected to the courses seem high for most students. The survey results revealed that 63% of the students for AP, 74% of students for PID, and 58% of students for DEA, rate the workload as high (score 6-4). However, a high

workload, if managed well, can be productive. It may simply suggest an increased study intensity, and thereby a positive influence on students' learning outcome (Bertel & Svarre Kristensen, 2018). The stated workload, however, does not say much about how motivated the students are. A high workload combined with a low sense of learning outcome can imply frustration and overload.

3.2. Level of Difficulty

To learn at their best, students have to be in the zone of proximal development, described as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). Facilitating the proximal development for individual students, as an incremental step, is hereby placed upon the teachers. Wood, Bruner, and Ross (1976) later introduced this facilitation concept as "scaffolding". Scaffolding is defined as a process that "enables a child or novice to solve a task or achieve a goal that would be beyond his unassisted efforts" (p. 90).

Teaching a course using the flipped learning approach for the first time can be considered a novel challenge. Part of the challenge lies with how to support and supervise the different aspects of students' needs, during their learning process in the flipped learning environment. The teaching practice has to create a scaffolded facilitation, which is important for reaching each student, and their ability to feel competent within the course activities (Wood et al., 1976). Our survey data shows that students find the courses moving on a high difficulty level, which in relation to the scaffolding principle, suggests the need for improved teacher support. Focus on the concept of scaffolding could be very useful for an improved teaching and learning environment, both for future 4th semester students and teachers.

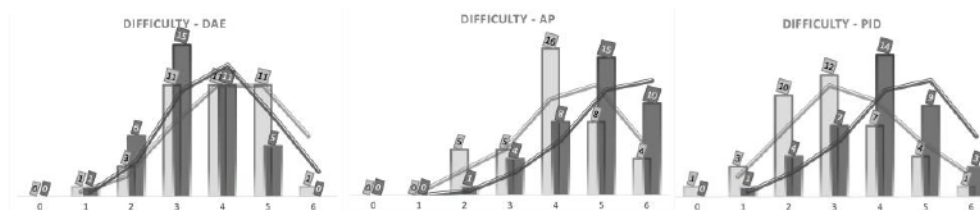


Figure 2. Students self-evaluated statement of the level of difficulty of the 4th semester courses. Evaluated from 0-6, where 0 is very low difficulty and 6 is very high. The dark gray color shows results from survey 2 (April), both when looking at bars and the trendline. The light gray color shows results from survey 1 (February), both when looking at bars and the trendline

The surveys, especially survey 2 (see figure 2), shows that courses are considered difficult. Both AP and PID students felt that the courses had become increasingly difficult. Two months into the course (survey 2), 87% of the AP students and 68% of the PID students expressed that the courses were very difficult, scoring it at 6-4. 42% of the DEA students consider the course very difficult answering 6-4; however, no student answered 6. In that same time frame, through in-class observations, we noted a decline in student participation in course activities. Survey 2 shows that 34% of students were attending less course lectures in April, compared to February. They gave three main reasons in their qualitative comments: 1) 'It is too difficult and I have fallen behind' 2) 'The in-class activities are too easy and are given too long time to complete' 3) 'I have personal problems or lack of personal recourses'. One student also commented that: "the understanding level of each student is not considered and the train goes, even without everyone understanding the material". From these comments, attaining the zone of proximal development across all students appears problematic. As a result, if students feel a lack of competence, they are prone to lose motivation for the courses, which may put students' participation and learning at risk. Scaffolding one's teaching practice has been a problem within higher education for years, not just within the PBL approach, but remembering to focus on scaffolding to support the learning process is integral for further experimentation for flipped and integrated semester development.

3.3. Integrating project work into courses

Learning the content and the importance of students' feeling of competence is, as stated earlier, just one of the three needs for being motivated. The flipped and integrated semester experiment is focused on creating a better integration of project work into the courses to generate more autonomy for the students in the course work. In this way, students might see the courses as important for reaching their project goal and get motivated for using the content of the courses. Survey 2 shows the degree to which students experience project work to be integrated into course work.

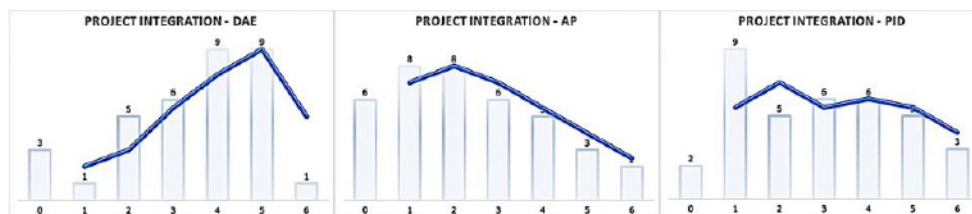


Figure 3. Students self-evaluated statements from survey 2 on how much they have worked with the semester project during classes. This question was not given to the students in survey 1. Evaluated from 0-6, where 0 means that no project-related work has taken place in the classes and 6 means that everything in the class are project-related work

Figure 3 shows how students have had different experiences between how well the project work had been integrated in the respective courses. In DAE, 24% of the students consider the integration as low answering 2-0, while 56% consider it as being high. Thereby, most students experienced a good integration and have worked the course into their project to a high degree. The results differ for the AP course as 58% of students consider the integration of AP as low (answering 2-0), while only 26% of students consider it high (6-4). 87% of the students in survey 2 also state that the AP course is difficult. Compared to survey 1, we see that the learning outcome is decreasing. With the PID course, the experiences are very different between students. 42% consider the integration as low (2-0), while 42% consider the project and course as well integrated.

3.4. Summary of the findings

The survey results reveal that the 4th semester Medialogy students consider the learning outcome as decreased, while we can also see that they consider the workload as relatively heavy. Furthermore, we can see that the students rate the courses' difficulty as increasing. However, this tendency is not shown in the DAE course, where students consider the learning outcome as high, and the course workload less heavy. This may be due to the fact that the DAE course has been running in a flipped configuration for several years, and thereby may have surpassed certain startup problems. It is also clear that the project integration is best at DAE, and that further refinement of the integration approach is essential for AP and PID, to better support students' motivation for course work.

4. Conclusions

This paper has first looked at the theoretical framework of applying the flipped learning approach into the AAU PBL model. The pedagogical premise of active learning underpins both the flipped learning approach and the PBL approach, which indicates that such an application should be supportive of student motivation and learning. Meanwhile, some structural problems were detected in the support of all three learning dimensions from the AAU PBL model and on the intrinsically motivating factors of the learning process. Motivating students in courses while working with a strict curriculum that is separately examined, has been shown to be challenging. For these reasons, a research group from the "Future directions for Problem Based Learning in a digital age" project, and teachers from the 4th semester at Medialogy (AAU CPH), developed a new structural approach for the full semester; a flipped and integrated semester. The integration of project work into courses were meant to support students' autonomy within course activities, thereby create a more motivating

learning environment. The experiment was run in spring 2019 through an explorative case study, which observed and collected survey data on students' learning processes. Comparing two surveys completed by students in February and April 2019 respectively, we see how students experienced the first encounter with the flipped and integrated experiment setup, as well as their experience a few months into the semester. By self-reported evaluation rating of their learning outcome, workload, difficulty of courses and how well the projects were integrated into the courses, preliminary findings for this experiment are presented. The results show that the students, particularly of 2 courses, AP and PID, experienced some difficulties during the semester, showing decreasing learning outcome over time, and an increase in perceived level of difficulty in workload. Furthermore, students commented that the two courses were considered to be very difficult, while the integration of the course content into the project was low. The results for the third course, DAE, however, were positive, possibly because this course has been using the flipped learning approach for several years and the students have had time to adjust to its content. Consequently, we can see how the students, in this case, consider the learning outcome as high, while the workload is stated to also be relatively high. The DAE course was also considered difficult, but not as difficult as the two other courses, and we see that students consider the integration between that course and the project better. Reasons for the differences in students' experiences of the three courses can be attributed to many different aspects within the specific teaching practices. Two variables stand out in this paper; the teachers' ability to successfully perform a scaffolded teaching practice, so students meet within their personal need for feeling competent and the degree of integration with project work that can support students' attainment of autonomy. Working on these motivational factors is important, when applying the flipped learning approach, and adjustments must be made during the upcoming 4th semester for Medialogy. Despite this, while integration may not fully work for all courses, the more flipped courses show that iterative experience with this approach may satisfy many of the students' motivation and learning needs.

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