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Title: **A Qualitative Investigation of Student Engagement in a Flipped Classroom**

Abstract

The flipped classroom is gaining acceptance in higher education as an alternative to more traditional methods of teaching. In the current study, twelve students in a Norwegian higher education institution were in-depth interviewed about their learning experiences in a two-semester long mathematics course. The first semester was taught using flipped classroom and the second semester using lectures, where both teaching modes contained a substantial amount of active learning. Overall, students report a more positive learning experience and higher engagement in the flipped classroom. The analysis revealed seven categories that the students highlight as especially conducive to their learning; commitment to peers, being recognized, feeling safe, instructor relationship, physical learning environment, learning with peers and using videos to learn new content. The results indicate that the affective dimension of student engagement is particularly prominent when students reflect upon learning in the flipped classroom.

Introduction

Recent developments in higher education have emphasized new and more learner-centered ways of teaching. The flipped classroom is one example of this shift where instructors and students have undertaken new roles. The flipped classroom is broadly defined by Abeysekera & Dawson (2014) as a set of pedagogical approaches that move information-transmission teaching out of class, use class time for active and social learning, and require students to complete pre- and/or post-class activities to fully benefit from in-class work. The delivery of course content is made possible in most cases by technological innovations such as video lectures, which is blended with in-class active learning designed to create meaningful student-instructor and student-student interactions. The flipped classroom as defined above is best understood as a pedagogical framework containing a vast array of different implementations, both with respect to out-of-class and in-class activities. The flipped classroom is a rapidly growing area of research, but still in a nascent stage. Despite popular enthusiasm, little research has been undertaken into flipped classroom approaches (Pawson, 2006), and Abeysekera & Dawson (2014) claim the flipped classroom approach is 'under-evaluated, under-theorized and under-researched in general'. According to a recent comprehensive scoping review of the flipped classroom literature by O'Flaherty & Phillips (2015), there is also a lack of conclusive evidence for the potential of the flipped classroom to offer a significant improvement over more traditional teaching forms in higher education. O'Flaherty & Phillips (2015) conclude that research findings have not yet converged to a single implementation model for the flipped classroom, but note that to best engage students and to promote learning, teaching approaches that go beyond the traditional lecture are the most effective.

The flipped classroom is a student-centered approach to teaching and learning that emphasizes student engagement and active learning, often as opposed to the traditional lecture. This latter mode of teaching is characterized as transmissive and passive, with little room for student participation. Especially in large classes, a major critique of the traditional lecture is the passivity it entails. Other critiques of lectures include low student attention and a learning environment supporting a surface approach to learning (Young, Robinson, & Alberts, 2009). In contrast, the flipped classroom is perceived to foster students' engagement and active learning through preparatory work, e.g. typically videos, and students being more active during class time (O'Flaherty & Craig, 2015). This student-centered approach emphasizes learning as activities that require students to be active participants in sharing, understanding and

constructing new knowledge (Damsa et. al 2015). Active learning is often contrasted to the traditional lecture and is generally defined as 'any instructional method that engages students in the learning process' (Prince 2004:1). Active learning is not just about organizing student activity (e.g. input) but it also requires students to do meaningful activities and to think about what they are doing (Prince 2004). In the flipped classroom, the role of the instructor changes to a more facilitator approach rather than a content provider. This in turn, mediates students' ownership of their own learning and self-regulative skills. This pedagogical approach can be beneficial for a number of reasons; students are able to learn at their own pace, access to technology such as videos provides flexibility as to when the students engage with it, and class time is allocated to discussions and group work.

In this article, we are interested in investigating students' perceptions of their learning experience in a flipped classroom contrasted with a more traditional mode of teaching. Most flipped classroom literature reports on student perceptions, student performance on test scores, or both, reporting case studies with a specific focus on subject domains and with limited amount of data collection. No clear picture has emerged on whether student achievement may be improved with flipped instruction, due to the wide array of subject matter across studies, often with only partial adoption of flipped instruction in some modules of the course, the lack of statistical control, and the many different flipped classroom formats. However, in a carefully designed randomized trial, Foldnes (2016) reports clear achievement gains in a flipped mathematics class relative to traditional lectures. Also other studies (e.g., Hung (2014) (foreign language), Mason (2013) (engineering) and McGivney-Burelle & Xue (2013) (mathematics)) have reported increased achievement gains through flipped instruction.

A large part of the research on student perceptions of the flipped classroom is based on quantitative analysis of student surveys (Gilboy, Heinerichs, & Pazzaglia, 2015; McLaughlin et al., 2014; Roach 2014; Wilson, 2013). However, O´Flaherty & Phillips (2015) argues that "Constructs such as engagement are not always easily reduced to measurable items on survey instruments or a reflection of examination performance and so warrant further investigation". Also, Abeysekera & Dawson (2014) conclude that more qualitative research investigating how students experience the flipped classroom is needed, while a recent review by DeLoziera & Rhodes (2016) emphasizes the need for studies investigating whether students' approaches to learning change when enrolled in a flipped versus a lecture-based classroom. Finally, in 20 studies published from 2013 to 2015 on the flipped classroom analyzed by Zainuddin and Halili

(2016), not a single study was found to employ a qualitative methodology. On the contrary, the authors found that the most frequently used methodologies in flipped classroom research was mixed methods approaches, followed by the quantitative approach (Zainuddin & Halili 2016).

We next review the rather sparse literature where qualitative research methods are used to investigate how students perceive the flipped classroom. Tawfik & Christopher (2015) analyses in-depth interviews to gain understanding of how students perceive the use of a problem-based learning approach in a flipped classroom context. They focus particularly on the use of videos for self-directed learning and for solving ill-structured problems. Tawfik & Christopher (2015) are mainly concerned with problem-based learning, and study how this may be implemented in a flipped classroom framework. They identify four main themes: relevance, reciprocal learning, teacher as facilitator, and self-efficacy. Of these, teacher as facilitator and self-efficacy are particularly relevant for understanding of student perceptions of the flipped classroom. Nguyen, Yu, Japutra & Chen (2015) used thematic analysis of in-depth interviews of students involved in a marketing class where only some modules were flipped. They identified three underlying dimensions to the flipped classroom: preparation, interaction with teacher and learning outcomes. Findlay-Thompson & Mombourquette (2014) analyze interview data from seven students in a business course where one third of the course was flipped, and report a mixture of positive and negative responses to the flipped classroom. In a learning environment mixed methods study, Strayer (2012) used field notes, interviews and focus groups to study differences in culture between a flipped classroom and a lecture-based classroom, and identifies types of activity, homework dynamics and in-class dynamics as three areas for student interaction. To sum up, these studies address some interesting aspects of the flipped classroom, but still leave a gap in our understanding of the flipped classroom. For instance, none of the above-mentioned studies focuses on psycho-social elements that may influence student engagement. We now proceed to give a pedagogical framework to enhance the understanding of the flipped classroom, where collaborative learning and engagement are important elements.

Theoretical Framework

We deem the socio-constructivist perspective of learning of particular relevance to any treatment of the flipped classroom from a pedagogical point of view. A key commonality within the socio-constructivist perspective is that of learning being socially constructed through

interaction, engagement and participation, and the term is an umbrella term for approaches which root learning in social interaction (Baird, Hopfenbeck, Newton, Stobart and Steen-Utheim 2014). In this view, learning is the result of student's continuous transactions between the environment and the individual (Sfard, 1998). This means that learning is based on engagement, activity and participation in interaction with peers, context and content. The role of social interaction in the development of cognition is a fundamental socio-constructivist premise in Vygotskys (1978) socio-cultural theory. The zone of proximal development is a key learning concept that can be defined as 'the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined by problem-solving under adult guidance or in collaboration with more capable peers (Vygotsky 1978:86)', and can be seen as a mechanism affecting students' self-regulation. Through interactions with more capable peers (or others), individuals learn to self-regulate through the actions made by others, internalizing them to actions made by themselves. We deem the social-constructivist perspective important for the current study because higher order cognitive functions, or deep learning, such as problem-solving, developed through interaction with oneself and others, is crucial for individuals' competence and knowledge development. As reflected in the above-mentioned discussion of flipped classroom (Abeysekera & Dawson 2014; O'Flaherty & Craig, 2015), a central component of a flipped classroom is to engage students in social and active learning, typically through preparatory work (out of class activities) with subsequent group collaboration (in class activities). Based on this we argue that the flipped classroom aligns well with the socio-constructivist perspective on learning and hence, that it offers a useful theoretical framework to investigate students' engagement in a flipped classroom.

Engagement plays a critical role in learning and achievement and has been increasingly researched, debated and theorized (Kahu, 2013). Scholars in the field seem to agree on its important role in higher education, in spite of its complex and multi-faceted meaning (Fredricks, Blumenfeld, & Paris, 2004). Student engagement is a meta-construct with many different levels that influence student learning, but also an element in which instructors can have some control. Other researchers claim student engagement is not only multi-faceted, but also dynamic, fluctuating, context-dependent and interactive (Goldin, Epstein, Schorr, & Warner, 2011). Three key dimensions of engagement - behavioral, cognitive and affective dimensions - as described by Fredricks et al. (2004), are widely acknowledged by scholars in the field. More recent developments on engagement (Kahu, 2013) broaden the view of the term by embedding

engagement in a larger conceptual framework taking into consideration the social-cultural context, where structural and psycho-social factors influence engagement. In turn engagement has academic and social consequences, both proximal (e.g., academic achievement) and distal (e.g., life-long learning). In summary, student engagement needs to be viewed as a psycho-social process, influenced by institutional and personal factors. Moreover, the socio-cultural context in which student activity is embedded, integrates both the behavioral and psychological perspectives of student engagement. For the purposes of the present study, we discuss our empirical findings in relation to the socio-cultural framework for student engagement as conceptualized by Kahu (2013) and the core dimensions affect, cognition and behavior of student engagement as discussed by Fredricks et al. (2004). These dimensions are acknowledged by Kahu (2013). Cognition refers to deep learning and self-regulation, while key elements for affect are enthusiasm, interest and belonging. The behavioral dimension relates to time and effort, interaction, and participation.

In conclusion, we are interested in the pedagogical value of the flipped classroom approach seen from a student perspective. The flipped classroom is aimed at fostering students' engagement and active learning in addition to support their construction of knowledge. However, we do acknowledge that the pedagogical value of the flipped classroom only partially can be explored from the student's perspective. Said that, we do believe the student perspective offers an important contribution to the understanding of flipped classroom as a learner-centered approach to teaching and learning. Underpinning our position is the view that a more in-depth understanding of students' engagement in a flipped classroom is needed, in view of the lack of in-depth qualitative research of students' perceptions of the flipped classroom model. To facilitate students' reflection, we designed the present study allowing for a meaningful comparison of the flipped classroom mode of learning with the lecture-based mode of learning. We were interested in what students' highlight as most important for their learning. Our research questions are as follows: How do students perceive the differences between the two modes of teaching? What do students highlight as important for their learning in the flipped classroom?

Methodology

Background

Our context is a first-year mathematics course with 235 (52% women, 48% men) registered students in a Norwegian business school. Mean student age was 21.1 years with a standard deviation of 3.3 years at the beginning of the course. The general level of mathematical skills at the beginning of the course was moderate, with many students having poor secondary education achievement in mathematics. The course was taught over two semesters.

As reported in a separate study (Foldnes 2016), during the first semester the student group was randomly allocated to a flipped classroom or to a lecture-based classroom. The flipped group was comprised of 93 students, who received flipped instruction for a 12-week period, while the control group of 142 students received traditional lectures. Foldnes (2016) presents a quantitative analysis of student achievement as measured by test scores which demonstrates substantially higher achievement in the flipped group. The 12 participants in the present study belonged to the flipped group of 93 students that received flipped instruction during the first semester. Given that these 12 participants had experienced a flipped classroom implementation proven successful in terms of student achievement, it is of considerable interest to investigate their reflections upon their learning experiences. During the second semester of the course, all 235 students (including the 12 participants in the present study) were taught with active-learning enhanced lectures. The 12 participants therefore received flipped instruction during the first semester, and active-learning enhanced lectures during the second semester. The concept of active-learning enhanced lectures will be explored in more depth below.

Study Design

Participants were exposed to two modes of teaching in a two-semester long introductory mathematics course. During the first semester, they participated in a flipped classroom, while the second semester they participated in a lecture-based classroom. By letting participants compare the two instructional modes as implemented in the same course, we control for factors like student cohort, course subject matter and instructor and teaching assistants. Student reflections will then not be confounded with these somewhat peripheral factors. The following figure describes the timeline of in-class and out-of-class activities for each mode of teaching.

[Figure one near here]

Face-to-face time both in the flipped classroom and in the lecture-based classroom contained substantial amounts of active learning elements. The choice of contrasting the flipped classroom to a lecture-based classroom enhanced by active learning was inspired by rather convincing evidence (Freeman et al., 2014; Jensen, Kummer, & Godoy, 2015) that active learning is a key factor to increased student engagement and performance. Evidence of particular relevance here, given that the present study is based on a mathematics course, is a recent comprehensive meta analysis (Freeman et al., 2014) of 225 studies, which compared student performance under traditional lecturing versus class sessions with active learning in undergraduate science, technology, engineering and mathematics courses.

We next discuss three important differences between the two modes of teaching. First, we note that the flipped classroom provided online videos as preparation material prior to each class session. These videos were screencasts produced by the instructor, where a 45-minute lecture session was condensed into a 10-15 minutes long video. In the lecture-based classroom students were instead given textbook exercises to work on between class sessions. The second difference concerns how the three hour in-class sessions were organized. In the flipped classroom students were asked to solve problems, first individually and then to regroup in fixed groups and discuss the same problems together. The problems were handed out on a sheet of paper at the start of the session. The aim of the group (consisting of 5-8 students) was to find common answers based on discussion and group learning. The instructor and two teaching assistants were present to guide the teams. At the end of each session, the instructor spent 25 minutes going through the problems and presenting solutions. Team scores were collected for an informal group contest, but these scores were not used for formal assessment. The decision to design collaborative learning experiences in fixed groups was inspired by the team-based learning framework (Sweet & Michaelsen, 2012). In the lecture-based classroom, students also spent a substantial amount, typically half of the time, on active problem solving, but they were free to work individually or in informal groups. The first half of each class session in the lecture-based classroom was devoted to lecturing, delivering the course content necessary to solve the problems that students worked on during the second half of the session. We provide a summary of the two teaching designs in Table 1.

[Table 1 near here]

The third difference between the two modes of teaching relates to the physical learning environment, which in the flipped classroom consisted of an open study area with tables, and with adjoining study cells containing a table and a whiteboard. Each cell could accommodate a student group during group learning sessions. The lectures were given in a traditional lecture hall, but students were free to leave the lecture hall during problem-based learning sessions and work together sitting at tables in an open study area next to the auditorium.

Participants

Participants in the present study were 12 first-year undergraduate students, four men and eight women, enrolled in a bachelor of business administration program at a Norwegian business school. All students were aged 19 – 24 years old, with the exception of one 43 year old student. Students' academic achievements were representative for the whole class, with marks mostly in the medium range. Also the participants' achievements in mathematics in secondary education ranged from the lowest mark to highest mark with most students at the medium to low marks. All participants were native Norwegian speakers. The participants were selected using purposive sampling (Creswell, 2014), representing a cross-section of the class, with respect to gender, age and academic performance, from a pool of interested students. Participation was voluntary and the students could, at any time, withdraw with no further notice. The participants were informed about confidentiality, and that the interview data was to be used for research purposes only. We reported the study to the Norwegian Social Science Data Services (NSD) from which we received an ethical approval for the research.

Data analysis

Through detailed analysis of semi-structured interviews (Creswell, 2014), the aim of the present study was to take an in-depth look at how first-year students perceive their learning experience in a flipped classroom contrasted with learning in a lecture hall, and what they highlight as important for their learning experience. We developed an interview guide with open - ended and flexible questions, with the aim to get access to the students' views, understanding and experiences on the subject (Silverman 2013). The first author interviewed the participants individually at the end of the students' second semester and before their final exam. We audiotaped the interviews, which each lasted 45 – 60 minutes. A student assistant transcribed each interview, adding up to 198 pages.

The interview data were analyzed using content analysis (Miles & Huberman, 1994). Content analysis is a flexible method for working with text data and is suitable when the aim is to elicit views and perceptions from the participants (Creswell 2014). Using emergent coding, the two authors established categories following some preliminary examination of the data (Silverman, 2013). We then compared our two lists of categories, discussing differences and then adjusting and uniting the categories. Third, a consolidated list was set up and independently applied again on the data corpus by both authors. A final comparison was then made, checking the reliability of the coding. The trustworthiness of the interpretations was developed through several discussions between the two authors, hence developing reflectivity in the process.

Results

From the analysis, we found seven themes that recurred in the data material. In this section we present and discuss these as our main results. The seven themes are:
- Commitment to peers
- Being recognized
- Reduced anxiety
- Instructor relationship
- Learning with peers
- Physical learning environment
- Using videos to learn new content

Our initial question in the interviews was which form of learning the students overall preferred, and a large majority of the participants said they preferred learning in the flipped classroom to learning in the lecture hall. Of the 12 participants, 11 preferred the flipped classroom to lectures, while one participant did not prefer one mode of teaching to the other. We believe the seven themes identified through the analysis may help understand why students favored learning in a flipped classroom.

In the following we discuss these themes, using excerpts from the interview material to illustrate students' reflections. The results are discussed as separate themes; we remark, however, that the richness of the qualitative data implies that some themes may partially overlap with each other.

Commitment to peers

Commitment to peers implies that students are willing to invest time and effort with their peers and, as our analysis showed, this was particularly evident in relation to group participation. We found that commitment to peers was a recurrent topic when students talked about the flipped classroom. Participation in group learning was voluntary in both modes of learning, but many participants expressed a sense of commitment to contribute to the group in the flipped classroom.

> Even though showing up to work with the group to solve problems was optional, it did not feel optional. You feel more obliged to come to the class session because you belong to a group. (Vibeke)

> ... a somewhat 'compulsory discipline' that made me participate in the group work. It was easier to come to class because of the group. You go to your group and then all members must contribute. (Martin)

We did not find evidence for such feelings of group commitment when students talked about group learning in the lecture-hall.

> In flipped, I wanted to come, to not let the others down. Showing up for a lecture, nobody notices whether you come or not. (Therese)

This might be due to the stronger structural support for group learning in the flipped classroom compared to the lecture-based classroom. In the flipped classroom, students were pre-assigned to fixed groups at the beginning of the semester, and were explicitly told to work with their group in each class session. In the lecture-based classroom, however, students were free to work in groups of their own choosing, or to work individually.

Moreover, the students highlight how commitment to the group contributed to a positive social learning environment, with a shared responsibility in the group, in relation to both subject matter and to peers: Vibeke, for example, reflects on how working in groups triggered a shared responsibility in the group, both in relation to the subject matter and to her peers:

...we made an effort, since it was not only up to each of us individually, but as a group. A community formed, it was fun to come and meet people. And math became fun. It was nice to sit together, and after a while we got to know each other and started to discuss more and more. There was really a sense of community around math. (Vibeke)

Feeling a sense of belonging, as articulated by Vibeke, Martin and Therese is one of the dimensions Kahu (2013) brings forward as influencing student engagement. The commitment these students experience in the flipped model influences their investment in the group, and when Vibeke says 'There was really a sense of community around math', she also expresses enthusiasm for the subject, described by Kahu (2013) as the affective dimension of engagement.

Being recognized

It is important for students to be recognized as individuals, both by their peers and by their instructor. Recognition by peers is more frequently mentioned when talking about the flipped classroom, where groups sit together over the whole semester. This recognition also implies commitment:

...in flipped, what is expected of you is more visible. This makes you want to perform well in group, you do not want to appear as someone who can not solve problems … In a lecture hall you can hide. You cannot hide in a flipped classroom. Many students need to be seen and to be motivated. (Inger)

Recognition by the instructor is also highlighted by some participants.

Flipped makes you more visible. The instructor may comment 'you did not come last week', and then you feel more committed to come to class. (Inger)

In flipped, the instructor sees you, that you do well, or says 'okay, let us help you a little bit'. And for me, this is crucial. I am not motivated by money or other external rewards. But being recognized, being told 'I see that you are good in math', is important, especially if you struggle with math. (Therese)

Relationships between student and instructor, are described by both Inger and Therese in the abovementioned excerpts. Such psycho-social influences on student engagement are important, engagement is not just about a student's 'internal static state', positioning the responsibility of engagement at the student, Kahu (2013) argues. The individual's experience is embedded within the socio-cultural context, and is influenced by both institutional and individual factors, such as the role of the instructor.

Reduced anxiety

Affective factors such as safety is related to the learning experience and is an important dimension of student engagement (Kahu 2013). Several students in this study reflect upon the emotional safety of the learning environment. This is Inger, reflecting upon the anonymity of the lecture-based classroom and how this makes her feel anxious:

> In the lecture hall, it is impersonal, and it does not feel natural to ask questions. You feel anxious again. (Inger)

> I never ask questions during lectures. Although I know many other students are wondering about the same issue, I still feel too embarrassed to pose questions in class. (Maren)

In these excerpts, Inger and Maren reflect on how the physical environment in the lecture hall elicits emotional feelings. The learning environment arouses negative feelings of anxiousness and embarrassment, while as in the flipped classroom students express feeling more safe to ask both peers and instructor questions:

> 'I found it easy to ask questions to my peers… in my experience, it was very... it was not a problem to ask questions and I never felt any discomfort asking whatever I was uncertain about. Not at all'. (Anne)

> 'I don't ask questions in class. I just don't. But in flipped, you have the possibility to talk to the instructor… you are located in the group room and the instructor walks

around and talks to us. Then we have the chance to say 'hey, I didn't understand this'. (Maria)

The physical premises in the flipped model makes it easier for the students to ask question to their peers and the instructor. In the flipped model, circulating around the group rooms, the instructor is more available to the students than in the lecture hall. It's easier to ask questions, and Anne refers to the affective dimension of engagement (Kahu, 2013) as she describes the feeling of discomfort in the traditional lecture hall.

Instructor relationship

The relationship to the instructor is perceived differently in the two modes of learning. Many students reported a closer contact to the instructor in the flipped classroom than in the lecture-based classroom. Some students remark that this contact is something they miss from secondary education.

It was easier to get in contact with the instructor in the flipped classroom. The instructor moves more around, and we just sit there and he will come around to us … Among my instructors, this is the one [the flipped classroom instructor] I know the best. The other instructors, which only lecture, they just lecture and leave again. It is something that I miss from high school, a closer contact with the instructors… It gives you the courage to ask questions. (Anne)

I liked the instructor availability [in the flipped classroom] in contrast to an instructor lecturing to many students. I feel one can better master the subject then, with a better relationship to the instructor, because you feel more safe and you look forward to coming to class. (Cecilie)

Flipped made it much easier to talk to the instructor, we felt we kind of knew him. (Kristoffer)

It was nice to have a more personal relationship to the instructor [in the flipped classroom], that he came by and talked to us during the class sessions. As a consequence, it is now easier for me to come by his office and talk to him. (Peter)

Kahu (2013) refer to Smith and Rob (2007) who argue that relationships with staff is important for student learning, and claim "...staff are considered to be the crux of the learning situation". Also, Kahu (2013) maintains the importance of instructors for student engagement, and Vygotsky (1978) point to the importance of dialogue in the relationship between instructor and students. Entries for interaction with instructor seem easier in the flipped classroom according to these students. The contact with the instructor these students establish, also have a positive effect to a broader social context, as explained by Peter above. Such psychosocial conditions influence student engagement, according to Kahu (2013).

Physical learning environment

For many students, the physical learning environment in the traditional lecture hall is perceived as a hindrance to establishing a relationship with the instructor. The lecture hall, a typical auditorium, in combination with class size reduces the students' possibilities to interact with the instructor and with peers. Other students also point to physical hindrances in the lecture hall, which feels limiting when the students are encouraged to work on problems.

> In the lecture hall you sit in long rows. It is hard to form groups there like we did in the flipped classroom. (Inger)

> You sit in a confined space, with barely room for your notebook. There is no blackboard in vicinity. If a peer student wants to explain things, there is kind of no space for explaining. (Vibeke)

> [In flipped] it happened that some of us understood how to solve it, and we were sitting in the group room where there was a small blackboard. We stood up and wrote on the blackboard, together, and solved the problem together in that way. (Cecilie)

These excerpts illustrate how the physical learning environment restricts these students' engagement. Student behavior, displayed as time and effort, interaction and participation (Kahu, 2013), is restricted by their physical learning environment. As Vibeke and Inger point out, in the lecture hall, the conditions for engagement are limited, and explanation and interaction is difficult. In the flipped class however, the teaching areas are more flexible, allowing for groups to establish their space. Cecilie also points to how the students use the tools available in the group room for their collaborative learning activities.

Learning with peers

The students emphasized learning in groups as important to their learning experience. Responses indicate that participation in groups supports their learning and engagement, mainly because of the possibilities to ask questions, discuss and collaborate with peers. In the flipped classroom, there were more possibilities for group learning, given that class sessions were organized with much time allowed for discussion in the fixed groups.

> [In the flipped classroom] we asked a lot of questions in the group. If an exercise was hard, we did not give up until each group member said, 'yes, I got it, I understand'. It was ok to redo the exercise eight times, if needed. It started usually with one of the 'brains' knowing how to solve it, and explaining it to us. Then, one of us had the 'aha' experience, and then this person could rephrase the explanation for us who did not yet understand. You see, having such an 'aha' experience, we can suddenly understand why and what our peers do not understand, and we can explain better to them. (Vibeke)

The role of the others' contribution to one's own learning, is highlighted in this excerpt, and point to the pedagogical principle 'zone of proximal development' as theorized by Vygotsky (1978). Peer learning, as exemplified by Vibeke, mediates student learning because the contribution of others' different levels of competencies support individual growth. The learning experience reach a culminating point when students reach an 'Aha' moment, which in turn, shapes these students' understanding for, and ability to help weaker performing students in the group.
In the following excerpt, Cecilie explain how her understanding takes place in the social learning space, after first doing an exercise by her own:

> Sometimes I thought that I had understood something, that I had found the right solution to an exercise, but sitting with my group I discovered that my understanding was clearly wrong (laughter). Other times, I thought that my solution to an exercise was wrong, but I found out with the group that I was correct, after all (Cecilie)

> It was really nice those times I could explain something to the others in the group, it made me feel well. Also, you learn yourself by trying to explain to your peers how to solve it. (Inger)

Both Cecilie and Inger describe how they engage in both individual cognitive activity and interaction with peers, a central point in the socio-cultural point of view on learning (Vygotsky 1978).

Kjetil, in this excerpt, points to how deep learning develops as a process over time and through interaction with peers:

> Later in the semester, we became better, and we started to construct debates among us, asking why a certain procedure was wrong, and why other procedures were correct. That was fun. (Kjetil)

Whilst Kristoffer is reflecting on the value of group work:

> The videos, they made you learn to walk, but you fall down continuously. With the group work, you learn to walk better. (Kristoffer)

Kristoffer highlights an interesting element in this excerpt as he compares the outcomes of videos and group work. Watching the video alone, Kristoffer expresses a lack of support in his learning process, whilst the group work, however, assume the support of others in the process of learning. The contribution of others' knowledge to individuals' knowledge is prevalent in group work, and a benefit for Kristoffers learning.

Therese describes how a more capable peer helped her in her own learning process:

> I was placed in a group with a girl that was very good in math. She became well trained in explaining us the things she knew. I learned a lot from her, but then I could also help explain the solution in a more simple way to other peers, in a nice circle of learning, I think. (Therese)

Therese highlight how learning is an ongoing process over time, and how her interaction with the more capable peer contributed to her learning. Therese's reflections also illustrate how one's own understanding and mastery of the task, developed through interaction with a more capable peer, is a necessary premise for Therese to complete the task again, in terms of simplifying knowledge to other peers. Working with exercises in the group, Therese is in her

'zone of proximal development' and with the appropriate support she experienced, her potential level of development was reached.

Using videos to learn new content

In general, students reported being highly satisfied with using videos. The students mention several reasons for this. One was the possibility to pause and rewind videos.

> I take notes during lectures, and also when watching videos. I stop the video and take notes. During lectures, things move too fast sometimes, so that you almost have to give up taking notes. With videos it is nice to be able to write in your own speed, and calculate at you own speed. (Therese).

> The big difference for me is that when I start wondering about something in the lecture, 'Why did this happen'? I start figuring and calculating to understand, and then, the lecture has proceeded, and he [the instructor] is long past that point. But in a flipped video, you can just rewind, and re-watch several times. (Vibeke)

It is not possible to pause the lecture and adjust it to individual pace. Therese and Vibeke reflect on these possibilities, and highlight how watching videos influences their learning behavior; taking notes and reflecting on the content. The videos make it possible to self-regulate their own learning, because the students can adjust the content by pausing and rewinding. This flexibility, to pause and rewind the videos, allows students a self-paced learning because they can adjust the learning pace according to their needs. Using strategies to master the knowledge when watching the videos, as Therese's and Vibeke's excerpts illustrate, reflect their cognitive engagement, as described by Kahu (2013), or as higher order functions, using a Vygotskian term (Vygotsky 1978). Higher order functions are crucial for individual's knowledge development, and are developed through interaction with oneself and others. In the lecture hall, however, the instructor carries on with the subject matter, paying little attention to the students' learning paces. Consequently, this might influence students' cognitive development and thus be a hindrance to further learning.

The way the videos were designed, triggered student interactions:

> In the videos, he presented some topic, and then a problem appeared. He told us to pause the videos, to solve the problem ourselves. We did that, and then we could see if our solution was correct, sitting at home. It was nice. (Martin)

> I never took notes during the videos, but I did the problems he posed in the video, so I learned something from watching the videos. (Peter)

However, for the videos to support student understanding, it is not enough just to provide videos with relevant content. Therese reflects on how they used the videos for learning:

> I liked the videos, but provided they operate in a combination with in-class group work. You need to apply what you learned in the video, by solving problems. You need to discuss and debate the problems with someone. (Therese)

The point made by Therese, is that the videos do not trigger learning by themselves. Rather, watching the videos provoke a need for discussion; a point made by Prince (2014) when he argues for the need for reflection when learning new content. The videos provide theoretical input, but Therese reflects on a need for a second step in her learning process; engaging in discussions. The individual cognitive activity taken by Therese, is central in learning, however, as learning is rooted in participation in social interaction (Vygotsky 1978) both the individual cognitive activity and interaction with others is important for Therese's cognitive development. Moreover, talking about application, Therese shows a motivation for deep learning, seeking further understanding. Being cognitively engaged, as these two excerpts illustrate, implies that Therese invests more mental effort in the task, and hence achieves new understanding (Fredricks et al., 2004).

Discussion

The cognitive and behavioral elements of student engagement have previously received much attention in the literature. However, like Kahu (2013) interestingly points out, engagement goes beyond this, and in the presented study we found strong indications that students felt more affectively engaged when learning in a flipped classroom. The fact that psycho-social dimensions' influence student engagement is important in our understanding of students' learning experiences and, consequently, for student learning and achievement. We believe that

the reported feelings of commitment, safety and recognition experienced in the flipped classroom have pedagogical value. Our results indicate that these feelings are related to the process of group participation and learning. The analysis also illustrated that development of knowledge emerged through the contribution of others during group participation. Although the lecture-based classroom was set up with ample opportunity for group learning, there was a stronger structural support for group learning in the flipped classroom. In the flipped mode of teaching, fixed groups were formed by the instructor at the start of the course, and group learning was a central part of each class session, allowing students to form social bonds over the course of the semester. It is our impression that the use of fixed groups was an important underlying factor for the strong affective engagement reported by many of the participants. Although the lecture-based instruction also provided possibilities for group learning, social learning occurred mostly in small ad-hoc groups which were not stable over the course of the semester. In the definition of the flipped classroom offered by Abeysekera & Dawson (2014), social learning plays a central role. Seen from a sociocultural perspective, the role of others' contribution to one's own learning is of outmost importance. Based on the present study, and that of Foldnes (2016), organizing class sessions with collaborative learning in fixed groups seems a particularly promising type of social learning, which can result in raised feelings of commitment, recognition and reduced anxiety, that we believe are beneficial to learning.

We remark that although the study design attempted to control for factors such as subject matter, student cohort and instructor, the physical learning environment and the class size was not held constant across the two learning conditions. Flipped instruction was given in a study area with a mix of tables and study cells, in a class of approximately 100 students. Lecture-based instruction was given in a traditional auditorium and an adjoining study area with tables, in a class with approximately 200 students. Note that these are nominal class sizes, and that in any given class session, fewer students were present (attendance ranged in the 60-70% interval, for both flipped and lecture-based classrooms). Hence, one weakness in the present study is that students received flipped classroom instruction in a smaller class compared to the lecture-based class. Although we do not believe that this difference in class size explains all of the perceived benefits of learning in a flipped classroom (none of the students explicitly mentioned that the class size was smaller in flipped), the smaller class size might have biased students' perceptions toward flipped learning. We believe this topic merits further investigation, that is, identifying factors (class size, group size, group formation, physical learning environment) that may affect the affective dimension of engagement in the flipped classroom.

Finally, we remark upon the impact of discipline. In the present study class sessions were focused on mathematical problem-solving. A large part of the exercises required procedural knowledge, i.e. how to find a sequence of actions that solve the problem, while a smaller portion of the exercises required conceptual knowledge, with little need for computations. The importance of procedural problem solving is somewhat specific to the STEM disciplines, and may therefore hinder generalization to other disciplines. However, the main finding of increased student engagement in the flipped classroom does not seem to be contingent upon the specific problem-solving activities used in the present study. Importantly, the increased affective intensity reported in the flipped classroom concerns social interactions between students and the instructor, group participation and learning, which in our opinion may occur in any flipped classroom implemented with strong focus on collaborative learning.

Conclusion

In this study, we have discussed students' perceptions of their learning experience in a flipped classroom and in a lecture-based classroom. Overall, the students report a more positive learning experience in the flipped classroom. Students list a variety of reasons for this, but a common link are the possibilities of engagement the flipped classroom entails. Student engagement is often conceptualized as having three dimensions: cognitive, behavioral and affective. To the best of our knowledge, previous literature on the flipped classroom has not investigated student engagement in light of these three dimensions.

A main conclusion drawn from the present study is that the affective dimension is especially stimulated in the flipped classroom, compared to the lecture-based classroom. For instance, students repeatedly reported a feeling of commitment to their peers. Other emergent themes that relate to student affect are the notions of feeling safe and of being recognized. The results also show that the cognitive dimension of engagement was more clearly displayed in flipped learning, with students learning more from their peers. We could also find indications of the behavioral dimension of engagement in the data material, but this was not prominent. However, as a whole, these elements are valuable for our understanding of student engagement in higher education, because they illustrate the complexity of the concept, as theorized by Kahu in her conceptual model (2013).

As a final word, we found that the students were more than willing to express their experiences with the two modes of teaching. Their enthusiasm for the flipped classroom model was striking and some students questioned why this was their first experience with the flipped classroom model. Student perspectives on learning experiences are valuable for the further planning and implementation of new learning and teaching methods and we urge practitioners and policy makers to take students' perspectives into account.

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Figure 1: Time line for in-class and out of class activities for each mode of teaching
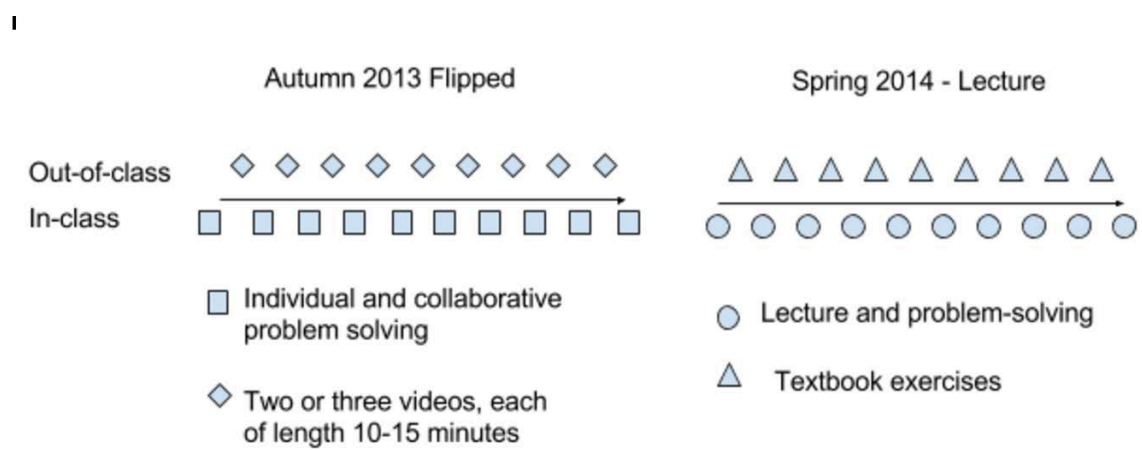

Figure 1

Tabel 1: Teaching design

Teaching Method	Pre-Class	In-Class, three hours sessions
Flipped classroom - Autumn 2013 pre-calculus	Students were asked to watch two or three videos to prepare for each class session. Each video lasted approx 10 minutes. The videos were hosted on YouTube.	First students worked individually for 60 minutes on twenty worksheet exercises. Then students gathered in teams to discuss the same exercises and agree on group-based solution. In the last 25-30 minutes the instructor solved the exercises on a blackboard. The teams reported their final score to the instructor.
Lecture classroom -Spring 2014 calculus	Students were given a set of homework problems from textbook. These related to the topic that was taught in the previous class.	A traditional lecture was given the first 60 minutes, covering the learning unit. During the next 60 minutes the students worked on exercises handed out on a worksheet. Students could work on these individually or in groups, either in the lecture hall or outside. In the last 25-30 minutes the instructor solved the exercises in the lecture hall.