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A case in undergraduate mathematics

Triantafyllou, Evangelia; Timcenko, Olga; Kofoed, Lise B.

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Student Behaviors and Perceptions in a Flipped Classroom:
A case in undergraduate mathematics

E. Triantafyllou[1]
PhD Student
Dpt. of Architecture, Design and Media Technology, Aalborg University
Copenhagen, Denmark
E-mail: evt@create.aau.dk

O. Timcenko
Associate Professor
Dpt. of Architecture, Design and Media Technology, Aalborg University
Copenhagen, Denmark
E-mail: ot@create.aau.dk

L. Busk Kofoed
Professor
Dpt. of Architecture, Design and Media Technology, Aalborg University
Copenhagen, Denmark
E-mail: lk@create.aau.dk

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INTRODUCTION

Over the past years, engineering education has been challenged to embed creativity and innovation into undergraduate and postgraduate programs, in order to produce graduates who can easily adapt to these changes [1]. Moreover, a number of engineering programs have arisen that transcend the division between technical, scientific and creative disciplines (e.g. Architecture and Design, Media Technology, Sustainable Design). In relation to mathematics education, this new development has led to a transposition from an industrial use of mathematics, where it is employed intensively by mechanical and construction engineers as a tool in order to develop products and build constructions, towards a situation where mathematics is increasingly used as the actual building blocks in various new digital products and creative expressions. This transposition has implications on how mathematics should be taught in such engineering studies.

This paper presents the introduction of the flipped classroom model to a statistics course at the department of Media Technology, Aalborg University Copenhagen.

[1] Corresponding Author
E. Triantafyllou
evt@create.aau.dk

Aalborg University applies the Problem-Based Learning (PBL) pedagogy in all its programs, which supports student-centred learning, active learning and group work [2]. However, we have found that mathematics courses at Media Technology follow mostly the traditional learning approach, the one way transmission model (lectures as presentation of information) [3]. Therefore, we decided to introduce the flipped classroom approach in mathematics related courses for Media Technology students for aligning them with the PBL pedagogy. The flipped classroom model, which employs computer-based individual instruction outside the classroom and devotes classroom time to group activities with the teacher as facilitator, is well justified by the core principles of PBL. In this paper we present student self-reported behaviours and perceptions on this new instructional model, which we collected by conducting two survey studies and two focus group interviews among students attending the statistics course.

1 BACKGROUND

The flipped classroom is a relatively new pedagogical approach, which has gained momentum in the last years. There have been various attempts to apply the flipped classroom in educational environments. For example, Love and Hodge compared a classroom using the traditional lecture format with a flipped classroom during an applied linear algebra course [4]. Students in the flipped classroom environment had a significant increase between the sequential exams compared to the students in the traditional lecture section, but they performed similarly in the final exam. Moreover, the flipped classroom students were very positive about their experience in the course, and particularly appreciated the student collaboration and instructional video components. Strayer compared a flipped statistics class with a traditional one [5]. He found that although students in the flipped classroom were less satisfied with classroom structure, they became more open to cooperative learning and innovative teaching methods.

However, there are also critics to this approach [6, 7]. Concerns include among others: criticism about the accessibility to online instructional resources, the growing move towards no homework, increased time requirements without improved pedagogy, teachers concerns that their role will be diminished, lack of accountability for students to complete the out-of-class instruction, poor quality video production, and inability to monitor comprehension and provide just-in-time information when needed. As a response to such concerns, researchers have proposed hybrid models of the flipped classroom. For example, the in-flipped classroom is designed to be a learning environment that consists of real and virtual teachers in the same classroom [8], while the holistic flipped classroom has teachers offering synchronous support to students both in and out of the classroom [9].

Besides critics, other researchers have noted that more research is needed on the flipped classroom in order to develop its theoretical foundation and to evaluate its contribution to the development of lifelong learning and possibly other skills [10, 11]. Abeysekera and Dawson proposed a theoretical framework for empirical investigation on the potential of flipped classrooms to cater for motivation and better management of the cognitive load (Figure 1). In the following, we discuss our findings on student behaviours and perceptions in a flipped statistics classroom using this framework.

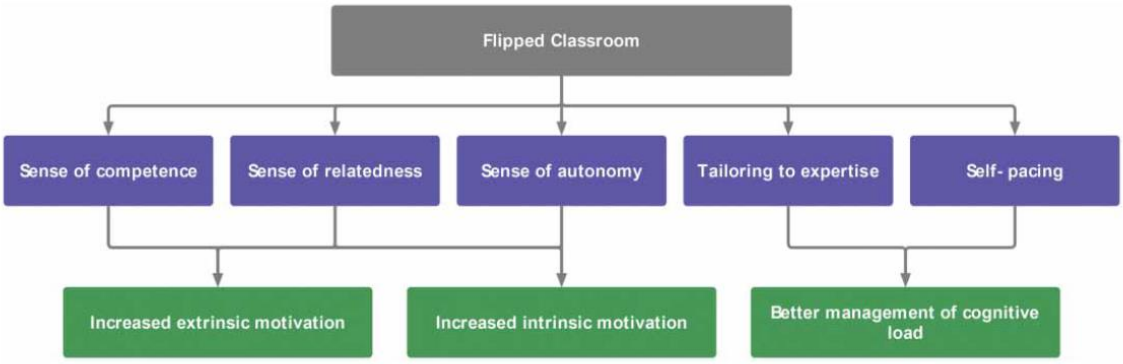

Figure 1. Theoretical model for the flipped classroom as proposed by Abeysekera & Dawson [10]

2 METHODS

We introduced the flipped classroom approach to a statistics course in the fourth semester of Media Technology. To provide students with instruction outside of the classroom (before the lectures), we created video recordings with the teachers of the course and a list with online resources about the topic of each class. Before classes, students had to study this material and also read suggested parts of the course book. Moreover, students had to submit their answers to multiple choice questions or to short exercises before attending each class. The questions and exercises covered the preparation material. We used these assignments in order to observe student understanding, misconceptions and common mistakes, and in order to motivate students to do their preparation. The information exchange between the teacher and the students (i.e. resources for out of classroom learning, assignments, news forum) and the hand-ins were facilitated by the Moodle VLE system. Class time was devoted to explanations by the teacher, problem solving activities and time for questions or clarifications. After each class, students had to submit what they did in classroom. This was an obligatory submission.

In order to explore student experiences and preferences on this new instruction model, we conducted two survey studies and two focus group interviews among fourth semester students. The first online survey was distributed after four classes using the flipped instruction model. The survey was designed to gather student perceptions on the out-of-classroom preparation. The second online survey was distributed after seven flipped classrooms and used a Likert scale in order to collect student opinions on issues raised by their answers in the first survey. Items in this survey were measured using an 11-point rating scales, with the range of answers from 0 (“strongly disagree”) to 10 (“strongly agree”). Both surveys were distributed to the students who were present in the classroom. For this course, 180 students were signed up, but not all of them are active and we know by experience that anyhow around 20% will not attend class. Since the survey was optional, it was not possible to ensure all students completed it.

Moreover, we conducted two focus group interviews with 7 students who volunteered to participate. We performed these interviews because we wanted to get qualitative data in order to learn more about the questionnaire responses.

3 RESULTS

3.1 First survey

In the first survey, we started to ask students if they had watched the videos given as preparation for the class that was about to begin. Then, there were items, where students could provide further information in an open-ended manner. The students who hadn't watched the videos had to describe their reasons for doing so (Table 1). The students who had watched the videos were asked to describe what they found interesting and what they found challenging during the class preparation (Table 2 and 3 respectively). We collected responses from 80 students. Among them, 74% had not watched the preparation videos.

Table 1. Please describe your reasons for not watching recordings for today's class.

I did not have time	25%
Due to technical problems with watching the recordings	12.5%
It is a repetition of the book / I can solve the assignments by reading the book	11.25%
The recordings are boring /slow	8.75%
I am not used to / I prefer traditional lectures	6.25%
The recordings were uploaded quite late	5%
I was ill	3.75%
I forgot	3.75%
I didn't know there were recordings	3.75%
No reason	2%
Lack of discipline / motivation	2%
I am familiar with the subject	1.25%
I use other resources	1.25%

Table 2. What was the most interesting part of the preparation for today's class?

Nothing	6.25%
I can pause/rewind as many times as needed	3.75%
The book	3.75%
The examples in the book	2.5%
The teacher explaining in the videos	2.5%
This instruction model is convenient	1.25%
The videos help to remember the material	1.25%
The explanations in the videos	1.25%
This instruction model allows you to reflect on yourself	1.25%
How easy it was to understand the material	1.25%

Table 3. What was the most challenging part of the preparation for today's class?

Recordings are poorly made/slow/boring	6.25%
Overwhelming amount of information/confusion about preparation material	5%
Technical problems in watching the videos	3.75%
The videos are a repetition of the book	2.5%
The complexity of the course	2.5%
The wording in some questions/examples	2.5%
No real life examples / bad examples	2.5%
Many videos to watch as preparation	1.25%
Videos available very close to the lecture	1.25%
Everything	1.25%

3.2 Second survey

In the second survey, we collected responses from 47 students. There were ten statements in this survey – five negative and five positive. The statements covered

the main topics raised by students in the first survey. The reported average "agreement" value and standard deviation for each statement is shown in Figure 2.

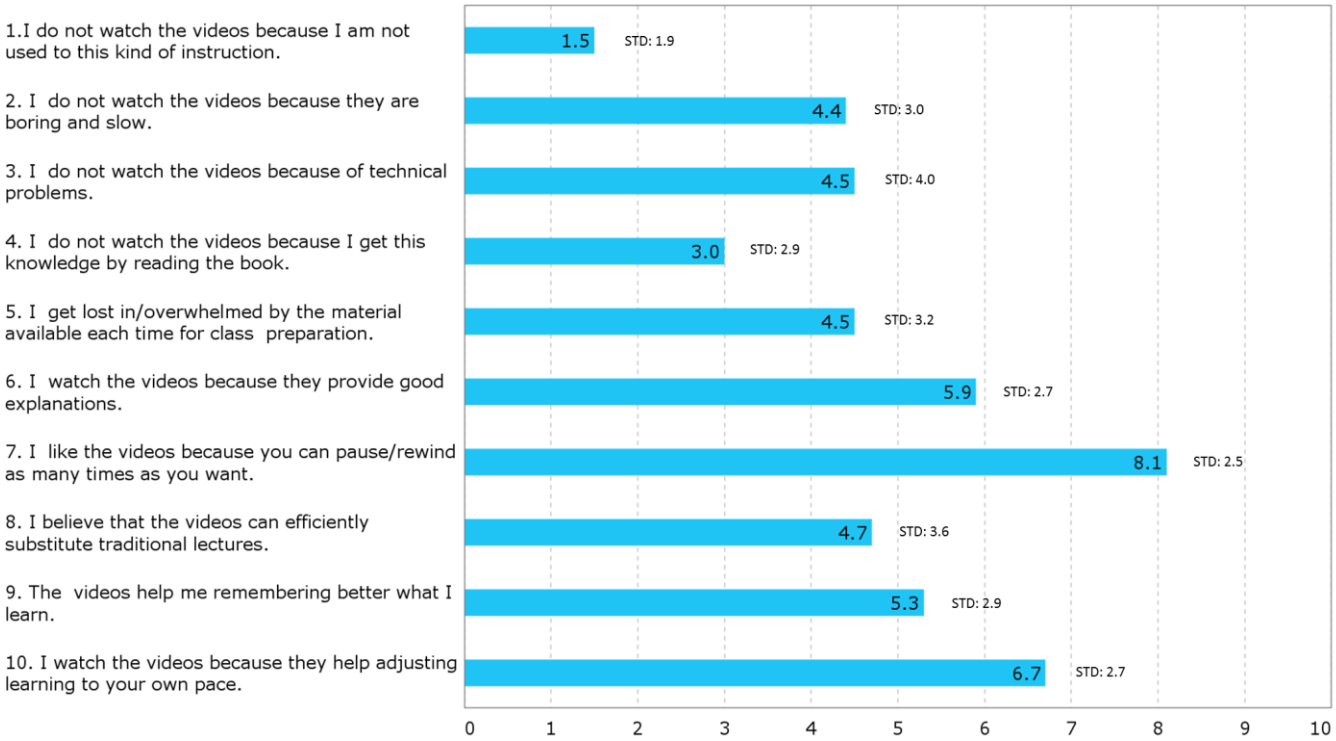

Figure 2. Average values and standard deviations of responses to the Likert scales (0: strongly disagree, 10: strongly disagree)

3.3 Focus group interviews

During the focus group interviews, students expressed their opinion on this new instructional method. Students seemed to have strong opinions and they tended to criticize this new approach. The main topics raised by the students as problematic are shown in Table 4 while the ones raised as strong points are shown in Table 5.

Table 4. Problematic issues raised by students during interviews.

Reaction to new: Since it is a new approach, there is some kind of confusion and also reaction.
Structure: It is not well structured and the material on Moodle is messy. The assignments should be linked to specific videos/reading material and be categorized according to their difficulty. A better reading guide should be provided explaining what is important and what is complementary.
Interaction in class: Class discussion does not always work because people do not want to talk in front of such a large audience / are afraid of saying something wrong or admit that they don't understand. Also contributing is not obligatory like at high school. There are students who leave the classroom when it is exercise time and others who do not come to the class if they haven't studied the preparation material.
Non-diligent students/too much lecturing: There are students who come to class unprepared so the teacher devotes time to explain what it had to be known. In reality, it looks more like a traditional lecture since not much time is devoted to assignments.
Assignments: A large amount of hand-ins. More time is needed for submitting hand-ins in order to have more time to reflect on what is done in the classroom.
Videos: Videos should not repeat what written in the book but instead provide explanations and deepen into challenging topics. Avoid technical problems by uploading videos on YouTube.

Table 5. Strong points of this approach as mentioned by students during interviews.

Better support: You get more help/support than in traditional lectures.
Solving exercises in class: Exercise time in the class with the teacher and teaching assistants is very helpful.
Studying at own pace: You can pause/rewind while studying and also use the preparation material at any time for refreshing knowledge.
Videos: It is faster watching the videos than reading the book.

4 DISCUSSION

In this section, we discuss the aforementioned results using the dimensions of the theoretical framework of Figure 1.

4.1 Sense of competence

The sense of competence refers to the need of students to feel competent to master the knowledge and skills and behaviours necessary to be successful in a given social context, and the sense of competence is also part of increasing extrinsic motivation. [10]. Our results show that students appreciate the fact that in the flipped classroom they get support and help while working with their assignments. Being able to solve the assignments and getting clarifications contributes to their feeling of success. However, students mentioned the technical problems with watching the video recordings that were present at the beginning of the course as demotivating. In the second survey though, the percentage of students who reported that technical problems prevent them from watching the videos was quite low.

4.2 Sense of relatedness

The sense of relatedness comes from belonging to a social group in a given context [10]. The in-class group activities can contribute to the development of this feeling. However, students expressed their concerns about student participation and contribution during these activities. Since it is a new learning environment, it is expected that students will need time to adjust to the new situation. Moreover, it is known from change management studies that one third of the employees will be against changes at the beginning of the changes [12]. Therefore, it is expected that some students will react to the changes in the learning and teaching methods and will report that they prefer traditional lectures. Nevertheless, most students disagreed with the statement about not watching the videos because they are not used to it. The reported concerns on in-class activities will also provide feedback to the research team for redesigning these activities and employing methods to actively involve more students.

4.3 Sense of autonomy

Autonomy satisfies the students' need to feel in control and independent, and together with the senses of competence and relatedness it might lead to increased intrinsic motivation [10]. The flipped classroom offers such opportunities to students. However, our results show that not all students can handle the offered autonomy. It is remarkable for example that almost 30% of the students report that they could not find the time or they forgot to study the preparation material. Therefore, students should learn to be more self-disciplined and to take responsibility of their own learning instead of expecting the teacher to "feed" them knowledge during traditional lectures.

4.4 Tailoring to expertise

The out-of-classroom instruction in flipped classrooms offers the opportunity to students to adjust learning according to their own expertise, which lead to better management of their cognitive load. There were students who reported having skipped preparation for a class because they were aware with the topic. Moreover, some others reported that they watched the videos several times because they found the topic challenging. Nevertheless, about 15% of the students found that the quality of the videos was poor and there was an overwhelming amount of information during class preparation. This is a matter that will be taken into consideration by the research team when adjusting the preparation material.

4.5 Self-pacing

Regarding self-pacing, the Likert scale on the ability to pause and rewind while watching recordings received the best average “agreement” value. This means that students really appreciate the fact that they study on their own pace which according to Abeysekera & Dawson lead to management of their cognitive load [11]. Moreover, students valued the explanations provided in the videos, while others mentioned that it is faster to watch the videos than reading the book. However, it was mentioned that more time is needed between different hand-ins in order for students to have more time to reflect on what they are learning.

4.6 Practical issues

This was our first attempt to employ the flipped classroom approach during a whole semester. Therefore, some technical issues came up while uploading the videos on Moodle. Moreover, the teachers had to get used to preparing recordings of their own lectures and some material was provided to students quite late. As mentioned before for students, teachers also need time to adjust to this new situation. However, the results of the second survey show more improved student perceptions on the flipped classroom, since they agreed with the positive part of the scale, while disagreeing with the negative part.

5 SUMMARY AND ACKNOWLEDGEMENTS

In this paper, we presented self-reported student behaviours and perceptions in a flipped statistics classroom. Our results confirm the fact that new teaching and learning methods need careful introduction and detailed information about how student behaviour has to change to use the new learning strategy. Moreover, we have noticed that students are very good at reflecting on the learning process but not on the learning content. Therefore, we need to help them reflect using appropriate out-of-classroom and in-class activities [13]. Our results show that the flipped statistics classroom has helped students to better manage the cognitive load but more work is needed on the motivational part. The initial technical problems played a decisive role in student motivation, because when the students cannot access the preparation material, they can get frustrated and find that they are wasting their time – especially the ones who are reluctant to change. Therefore, we believe that better structure and organization in the flipped classroom and increased student familiarization with this new approach will contribute to increased student motivation.

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