

**Student evaluation of the flipped classroom instruction method: is it aligned with Problem-Based Learning?**

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*PBL, Social Progress and Sustainability*

Edited by

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Edited by Aida Guerra, Fernando José Rodríguez, Anette Kolmos, Ismael Peña Reyes

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# Student evaluation of the flipped classroom instruction method: is it aligned with Problem-Based Learning?

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## Abstract

The flipped classroom approach is an instructional method that has gained momentum in the last years. In a flipped classroom the traditional lecture and homework sessions are inverted. We believe that the flipped classroom, 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 Problem-Based Learning (PBL) and therefore we applied for two consecutive years the flipped classroom approach to an undergraduate statistics course during a whole semester. This paper presents data from the second year, where we conducted a survey study among students participating in the flipped statistics course. This study consisted of two surveys designed to gather student perceptions on the out-of-classroom preparation material (videos and quizzes) and the flipped classroom in general. The videos were considered by students as providing nice explanations and improving understanding and they were valued for being available at all times and providing the option to watch them on one's own pace. The main challenge with the videos was some production issues. The quizzes were valued for helping with testing, memorizing and applying knowledge, while their main weak points were that they were too short, too easy and they contained in some cases unclear questions. Finally, the main strong points of the flipped classroom approach according to students were that it focuses on self-directed learning and individual learning paths and that one gets help during exercise time. Regarding the weak points, students reported the challenges of students coming to class ill-prepared, or students skipping class, and the amount of time spent on preparation. In the final part of this paper, we discuss the aforementioned results through a PBL perspective and we project them in a PBL context.

**Keywords:** flipped classroom, online videos and quizzes, student evaluation, mathematics, PBL

**Type of contribution:** research paper

## 1 Introduction

The flipped classroom approach is an instructional method that has gained momentum in the last years (Bishop & Verleger, 2013). In a flipped classroom the traditional lecture and homework sessions are inverted. Students are provided with online material in order to gain necessary knowledge before class, while class time is devoted to clarifications and application of this knowledge. The course content, which is provided for self-study, may be delivered in the form of videos and/or pre-class reading and exercises, while class time is mainly used for group work activities. The hypothesis is that there could be deep and creative discussions when the teacher and students physically meet. This teaching and learning approach endeavors to make students owners of their learning trajectories, and relies heavily on current technology.

Various researchers and instructional designers have sought to investigate the advances in flipped learning environments, e.g. (Bergmann & Sams, 2012; Strayer, 2012). According to such studies, students were very

positive about their experience and instructional video components in flipped classrooms and suggested that flipped classroom approach (1) provided them with an engaging learning experience, (2) was effective in helping them learn the content, and (3) increased self-efficacy in their ability to learn independently. While the aforementioned approaches report on benefits of the flipped classroom, there are also critics to this approach (Kellinger, 2012; Nielsen, 2012). Concerns include among others: criticism about the accessibility to online instructional resources, the growing move towards no homework, 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.

Taking into consideration the reported strengths and weaknesses, we applied for two consecutive years the flipped classroom approach to a university statistics course during a whole semester. During the second year, we conducted two survey studies among students attending this statistics course. In this paper, we report and discuss students' responses in these two surveys regarding learning with online videos and quizzes and the flipped classroom as an instruction method.

## **2 Background**

There have been various attempts to evaluate the flipped classroom and its accompanying online material in educational environments. Tune et al. conducted a study to assess the effectiveness of a traditional lecture-based curriculum compared to a "flipped classroom" curriculum of cardiovascular, respiratory, and renal physiology delivered to first-year graduate students (Tune, Sturek, & Basile, 2013). Students in both courses were provided the same notes and recorded lectures. However, students in the flipped classroom were required to watch the prerecorded lectures before class and then attend class, while attending lectures and watching the prerecorded lectures was optional in the traditional curriculum. In the flipped classroom, students received a quiz or homework covering material in each lecture, while there were no quizzes in the traditional curriculum. The effectiveness and student performance were evaluated by having students in both courses take the same multiple-choice exams and blinded student surveys. The results indicated that students in the flipped course performed better in the final exams and that the use of homework and in-class quizzes were critical motivating factors that likely contributed to the increase in student exam performance.

Love et al. compared a classroom using the traditional lecture format with a flipped classroom during an applied linear algebra course (Love, Hodge, Grandgenett, & Swift, 2014). 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.

Yoon and Sneddon surveyed students on their use of recorded lectures in two large undergraduate mathematics courses (Yoon & Sneddon, 2011). In this survey study, they investigated patterns in student use of recorded lectures and live lecture attendance, how and why they used recorded lectures and how this use was associated with their final grade. The results suggested that the practice of missing live lectures intentionally because the recordings were available was not associated with final grade. However, those respondents who intended to watch more recorded lectures than they actually did achieved significantly lower grades.

Bates and Galloway conducted a practice-based case study of curriculum redesign in a large-enrolment introductory physics course (Bates & Galloway, 2012). The course followed a flipped classroom approach, where lectures were transformed to guided discussion sessions, with focus on peer instruction techniques and discussion facilitated by extensive use of clicker questions. Their results suggest student engagement with pre-class reading and quiz tasks, positive student perceptions of this different instructional format and evidence for high quality learning.

In this paper, we present the results of a survey study that investigated student evaluation of online videos, quizzes, and the flipped classroom approach during a flipped undergraduate statistics course. More precisely, the study aimed at answer the following research questions:

- What are the strong and weak points of online videos and quizzes used in a flipped classroom according to students?
- How do students perceive the flipped instruction approach?

Our hypothesis was that the videos and quizzes would be perceived as contributing to the understanding and self-directed learning by students. In regards to the flipped classroom approach, we hypothesized that it would be perceived as an instruction method that helps students to take responsibility of their learning and improving the learning process.

### 3 Methods

In the last two years, we have introduced the flipped classroom approach to a statistics course in the fourth semester of the bachelor program in Media Technology at Aalborg University Copenhagen, Denmark. 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 short quizzes (multiple choice questions or 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. During class, a question round took place, in order to clarify aspects that students found challenging. Then, students were provided in-class assignments to reflect on, discuss, and practice what they had learned. The classroom activity was mainly not teacher led; instead, students in groups worked on the assignments while the instructor provided individual guidance as needed. The in-class activities were structured so as to provide students with a variation of the tasks they completed when watching the video, providing opportunity for both practice and transfer of learning to new situations. After each class, students had to submit what they did in classroom. This was an obligatory submission. The information exchange between the teacher and the students (i.e. resources for out of classroom preparation, assignments, news forum) and the hand-ins were facilitated by the Moodle VLE system.

During the first year, we conducted two survey studies and two focus group interviews in order to investigate student behaviors and perceptions in the statistics flipped classroom. The data gathered and the conclusions of the first year are reported elsewhere (Triantafyllou, Timcenko, & Busk Kofoed, 2015). These results have informed adjustments on the preparation material (videos and quizzes) for the second year. This paper presents data gathered during the second year, where we conducted two survey studies

among fourth semester students. These survey studies were designed to gather student perceptions on the out-of-classroom preparation material (videos and quizzes) and the flipped classroom in general.

The first online survey asked students if they had watched at least some of the preparation videos and if they had taken at least some of the preparation quizzes. If the answer to any of these questions was positive, the students were provided with two open-ended questions on the strong and weak points of videos and/or quizzes. In case the answer was negative, the students were asked the reasons for not watching the videos and/or taking the quizzes. Finally, there were two open-ended questions on the strong and weak points of the flipped classroom approach in general. This survey was distributed to the students present in class after four classes using the flipped instruction model. We collected responses from 25 (response rate=69.4%) students. The second online survey was distributed to the students present in the last class of the semester (after thirteen flipped classrooms). Eighteen students (response rate=60%) responded in the second survey, which was identical to the first one.

The answers to the open questions were analysed using an inductive approach for qualitative analysis (Miles & Huberman, 1994). During this data analysis, consensus on findings was sought among all authors of this article in order to ensure a deep reflexive analysis and to strengthen the validity of the findings. Furthermore, two of the authors were actively involved in the course, which greatly assisted in interpreting students' answers and experiences. In the following section, we present student responses in the two surveys.

## **4 Results**

### **4.1 First Survey**

In the first survey study, all students (100%) reported that they had watched at least some of the videos before class, while 92% (two students) reported that they had taken at least some of the preparation quizzes. One of the students who did not take any of the quizzes argued that s/he didn't feel prepared enough to take the quiz before class, while the other did not provide any reasons for that.

The student responses concerning the strong and weak points of the online videos are summarized in



Table 1, while the responses on the strong and weak points of the online pre-class quizzes are shown in Table 2. Finally,

Table 3 summarizes the student responses on the strong and weak points of the flipped classroom approach. For building these tables, we have grouped answers with the same meaning but different wording.

## **4.2 Second Survey**

In the second survey study, there was only one student out of eighteen who reported that he neither had watched any video nor had taken any of the quizzes (94.4% had watched at least some videos and taken at least some quizzes). This student argued that he did not have the time so far to study for the course but he would start studying in the coming weeks.

Table 1: 1<sup>st</sup> survey responses to the questions: "What are the strong/weak points of the videos?" (N=25)

Strong points of videos		Weak points of videos	
Provide nice examples/explanations	28%	Production issues (viewer, readability, language, camera, browse)	36%
Sum up main points well	28%	Should be longer to cover the book/be similar to a lecture	20%
Easy to understand/follow/learn	24%	None	12%
You can pause, rewind	20%	Too long/too slow	12%
Contain slides you can follow	16%	Not engaging/boring	8%
Help understand/memorize the book content	15%	Lectures similar to videos	8%
To the point/clear	12%	Not able to ask questions	8%
Videos and book complement each other	8%	Hard to prepare for class during "free time"	4%
Someone explaining to you	8%	Reading the book/internet is better	4%
Available at all times	8%		
Faster than lectures	4%		
Not as boring as the book	4%		

Table 2: 1<sup>st</sup> survey responses to the question: "What are the strong/weak points of the quizzes?" (N=23)

Strong points of quizzes		Weak points of quizzes	
Test your knowledge	47.8%	They are too short	21.7%
Re-inforce learning	13%	Too easy	17.4%
Help to memorize knowledge	13%	None	13%
They are short	13%	Formulation of questions	13%
Not hard, not easy	8.7%	I don't know	8.7%
Active thinking	4.3%	They don't always cover the video content	8.7%
Able to apply the knowledge	4.3%	Trick questions	4.3%
Prepare for class	4.3%	Not able to see the previous answer	4.3%
Help to focus on important aspects	4.3%	Not able to see the right answer	4.3%
Not mandatory	4.3%	They are boring	4.3%

Table 3: 1st survey responses to the question: “What are the strong/weak points of the flipped classroom approach (FL)?” (N=25)

Strong points of the FL approach		Weak points of the FL approach	
Get help during exercise time	36%	Challenging if you don't prepare	16%
Deep discussions in class	20%	Too much time on preparation	12%
Preparation and repetition on own tempo	20%	No reason to go to class if you study on your own	8%
Re-enforces learning (learn before, during, after)	20%	None	8%
Motivating/Challenging	20%	Different tempo of solving exercises in class	4%
Focuses on self-directed learning	16%	Self-directed learning is risky	4%
I don't know	8%	I don't like it/don't learn that way	4%
No repetitions in class	4%	Repetitions during class time	4%
Application of knowledge	4%	Lectures sometimes not well-structured	4%
		Difficult to catch up with exercises if you miss a lecture	4%
		I don't know	4%

The student responses in the second survey concerning the strong and weak points of the online videos are summarized in Table 4, while the responses on the strong and weak points of the online pre-class quizzes are shown in Table 5. Finally, Table 6 summarizes the student responses on the strong and weak points of the flipped classroom approach.

Table 4: 2<sup>nd</sup> survey responses to the questions: “What are the strong/weak points of the videos?” (N=17)

Strong points of videos		Weak points of videos	
You can pause, rewind	35.3%	Not able to ask questions	29.4%
Easy to understand/follow/learn	29.4%	Production issues (viewer, readability, language, camera)	17.6%
Provide nice examples/explanations	23.5%	Too long/too slow	17.6%
Available at all times	17.6%	Similar to book	17.6%
Sum up main points well	11.8%	None	11.8%
Contain slides you can follow	11.8%	Do not cover everything in the book	11.8%
To the point/clear	11.8%	Not concise	5.9%
Help understand/memorize the book content	5.9%	Book/internet is better	5.9%

Table 5: 2<sup>nd</sup> survey responses to the question: "What are the strong/weak points of the quizzes?" (N=17)

Strong points of quizzes		Weak points of quizzes	
Test your knowledge	64.7%	They are too short	17.6%
Re-inforce learning	17.6%	I don't know	17.6%
Able to apply the knowledge	11.8%	Formulation of questions	17.6%
I don't know	5.9%	Can get good grades by trial & error	11.8%
Active thinking	5.9%	None	11.8%
None	5.9%	Hints not very helpful	5.9%
Help to memorize knowledge	5.9%	Not able to see the previous answer	5.9%
They are short	5.9%	Not available before next lecture	5.9%
Prepare for class	5.9%	Overwhelming amount of questions	5.9%
		They were not discussed during lectures	5.9%
		Cover material not included in videos	5.9%

## 5 Discussion

Based on the results presented in the previous section, we can argue that the majority of the students watched at least part of the videos and took at least some of the online preparation quizzes. Compared to our previous studies on the flipped classroom, these percentages are relatively high. This fact can be partly attributed to stricter admission rules imposed at the Media Technology program one year ago and partly to the improvement of the flipped course design, since this was the second iteration.

Regarding the strong points of the online videos, the same topics appeared in both surveys. The most recurrent topics were that videos provide nice examples and explanations, they sum up main points well, and they are easy to understand, follow, and learn with. Moreover, students included as a strong point the option to pause and rewind a video as many times as needed. Regarding the weak points, there were also similarities in student responses between the two surveys. The weak points mentioned as dominant in both surveys were various production issues (problems with the viewer, readability of the slides used in the videos, language issues and the camera position) and the videos being either too long or too slow. However, in the first survey students also mentioned that the videos should be longer in order to look like a video-recorded lecture. In both surveys, about 12% of students mentioned that the videos had no weak points. Finally, although the fact that students were not able to ask questions while watching the videos was the most popular weak point in the second survey and it has been also mentioned in our previous studies on learning with online videos, only 8% of the students mentioned it in the first survey.

As far as the strong points of the online quizzes are concerned, the most popular aspects among responses in both surveys were that the quizzes help to test student knowledge and to apply and memorize knowledge. Moreover, the students mentioned that they re-inforce learning. One student mentioned as a strong point that the quizzes were not mandatory, which was not true. We hypothesize that this was due to the student's misunderstanding. Regarding the weak points of the quizzes, students mentioned in both surveys that they were too short, too easy and the formulation of the questions in the quizzes was sometimes confusing. In both surveys, about 12% of the students reported that there were no weak points in the quizzes.

Table 6: 2<sup>nd</sup> survey responses to the question: “What are the strong/weak points of the flipped classroom approach (FL)?” (N=18)

Strong points of the FL approach		Weak points of the FL approach	
Apply knowledge in practice	38.9%	No explanation round in class	33.3%
Get help during exercise time	33.3%	None	16.7%
Online videos helpful	27.8%	Challenging if you don't prepare	11.1%
Re-enforces learning	11.1%	Self-directed learning is risky	11.1%
Follow without being present in class	11.1%	Communication problems	11.1%
Motivating/Challenging	5.6%	Same as lectures	11.1%
Preparation & repetition on own tempo	5.6%	Too much time on preparation	5.6%
Focus during lectures because of prior preparation	5.6%	No reason to go to class if you study on your own	5.6%
		I don't like it/don't learn that way	5.6%
		Too much time on recapitulation	5.6%

In both surveys, students were asked about the strong and weak points of the flipped classroom approach. As strong points, the possibility to get help during exercise time, and the ability to provide individual learning paths and re-inforce learning were popular topics present in both surveys. In the first survey, students also mentioned that they valued the fact that this approach focuses on self-directed learning, and that deep discussions were taking place in class. In the second survey, these aspects were not mentioned. One of the main advantages of the flipped classroom, which is that one can follow the course without being present in class, was only mentioned in the second survey. Regarding the weak points of the flipped classroom approach, the main points included the challenges of students coming to class ill-prepared, or students skipping class, and the amount of time spent on preparation. However, the most popular weak point according to student responses in the second survey was the lack of an explanation round in class. This is a point worth investigating with the teachers of the course, since the course design included an explanation round at the beginning of each class. However, this point is mainly connected to the specific implementation of the flipped classroom approach and not the flipped classroom in general. Finally, 8% and 16.7% of the students participating in the first and the second survey respectively mentioned that there are no weak points in the flipped classroom approach.

## 6 Projection on a PBL context

In the literature, there have been used various theoretical frameworks to justify the flipped classroom and support the design of in- and out-of-class activities. Such theoretical frameworks typically argue for the benefits of student-centred and collaborative learning (e.g. active learning, problem-based learning, peer-assisted learning) (Bishop & Verleger, 2013). Throughout our research, we are inspired and guided by the Problem-Based Learning (PBL) pedagogy, which is applied at Aalborg University since its establishment in 1974 (Barge, 2010). PBL is a student-centered instructional approach, in which learning begins with a problem to be solved. Students need to acquire new knowledge in order to solve the problem and therefore they learn both problem-solving skills and domain knowledge. The goals of PBL are to help the students “...develop flexible knowledge, effective problem solving skills, self-directed learning, effective

collaboration skills and intrinsic motivation.” (Hmelo-Silver, 2004). The results presented in this paper show that the flipped classroom is well aligned with the PBL core principles, since students reported that this instructional approach contributes to self-directed learning and increased motivation (Table 3). Moreover, students favoured quizzes for contributing to applying knowledge in the context and for helping them in problem solving.

At Aalborg University, PBL is also combined with group work (Kolmos, 1996). While working in groups, students try to resolve the problem by defining what they need to know and how they will acquire this knowledge. This procedure fosters the development of communication, collaboration, and self-directed learning skills. Moreover, group work in PBL may enable students to experience a simulated real world working and professional environment, which involves process and communication problems and even conflicts, which all need to be resolved to achieve the desired outcome. The students, who participated in our survey study, were asked to work in groups during in-class activities but not all of them followed this instruction. We thought that this would come naturally to students, since they were already divided in groups for working in their semester projects, but this was not the case for everyone. We believe that the classroom setting did not help to this direction, since the in-class activities took place in a traditional lecture room. Moreover, not all students were present in the in-class sessions, so there were students without their group members.

Finally, PBL represents a paradigm shift from the traditional one way instructional methods. In PBL, the teacher is not an instructor but rather a tutor, who guides, supports, and facilitates the learning process. The tutor has to encourage the students and increasing their understanding during the problem-solving process. Therefore, the PBL teacher facilitates and challenges the learning process rather than strictly transmitting domain knowledge. The flipped classroom that employs computer-based individual instruction outside the classroom and devotes classroom time to group activities with the teacher as facilitator is well aligned with the teacher's role in PBL. The goal of a flipped classroom is to let the student study individually at her own pace while providing the appropriate support material for out-of-classroom instruction and then come into class, where groups of students engage in group activities facilitated by the teacher. The student responses have also underlined these aspects of the flipped classroom (Table 3 and 6).

## **7 Conclusion**

This paper presented data from the second year of a flipped statistics course implementation, where we conducted a survey study among students participating in this course. This survey study consisted of two surveys designed to gather student perceptions on the out-of-classroom preparation material (videos and quizzes) and the flipped classroom in general. In general, the student responses in both surveys express positive feelings about the flipped classroom approach and the preparation material used in this flipped course. Moreover, we observed that the same topics in both strong and weak points of videos, quizzes, and the flipped classroom appeared in both surveys. The videos were considered by students as providing nice explanations and improving understanding and they were valued for being available at all times and providing the option to watch them on one's own pace. The main challenge with the videos was some production issues. The quizzes were valued for helping with testing, memorizing and applying knowledge, while their main weak points were that they were too short, too easy and they contained in some cases unclear questions. Finally, the main strong points of the flipped classroom approach according to students were that it focuses on self-directed learning and individual learning paths and that one gets help during exercise time. Regarding the weak points, students reported the challenges of students coming to class ill-

prepared, or students skipping class, and the amount of time spent on preparation. These results showed that the flipped classroom approach is well-aligned with the PBL principles and can be used to enhance learning in PBL context. We believe that the results of this study may be used to inform future designs and implementations of the flipped classroom approach, and especially the production of preparation material. However, more research involving larger student population is required in order to be able to generalize the results of this study for other contexts.

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