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Student engagement: Potentials of the flipped classroom approach

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Abstract

This article explores the blended learning model of flipping the classroom in the context of higher education across a range of disciplinary settings to examine student engagement. Flipping the classroom is a model that reverses at-home assignments and in-person classroom lectures. Pre-recorded lectures are viewed outside of the class, and in-person classroom time is devoted to interactive activities. Our aim was to explore the flipped classroom's potential and pitfalls, particularly in the context of the problem-based learning model applied at Roskilde University. We implemented the flipped classroom approach in our own teaching as experiments in five independent interventions. Through observing each other's classes, surveys, and reflexive notetaking, we experienced the approach to increase students' emotional engagement, as it gives more time in the classroom for interactive activities. According to constructivist learning theory, these activities stimulate learning. From a teacher's perspective, it was generally experienced as rewarding, but also time consuming.

Introduction

A central challenge in higher education today is maintaining a high level of student engagement and active learning (Erbil, 2020; Steen-Utheim & Foldnes, 2018; Kahu, 2013). Limitations of traditional lecture-based teaching have often been observed, particularly in courses where students are required to learn specific practical skills. Frequently, insufficient time is allocated for active learning, which provides students with hands-on experience related to the method or content of the class. Research shows that traditional teacher-led master classes are often not useful to students because they are unable to absorb all the information being taught, leading to feelings of disengagement and being overwhelmed (González-Velasco et al., 2021). Against this background, the flipped classroom model offers an alternative. We – a group of five early-career university teachers from different fields and institutes at Roskilde University – wanted to explore the potentials of this model by implementing it into our own teaching practice. Every member of the group redesigned one class they teach accordingly, and in this article, we report on our findings. Previous research suggests that the flipped classroom approach offers an innovative way to address the limitations of traditional teaching methods by

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facilitating an active and engaged learning experience for students (Erbil, 2020; Mingorance Estrada et al., 2019). This learning model reverses at-home assignments and in-person classroom lectures (Hawks, 2014; Bergmann, 2012; Lage et al., 2000). Students view pre-recorded lectures outside the classroom, while in-person classroom time is dedicated to interactive exercises, discussions, or group projects. In this manner, more time can be utilised for interactive learning activities such as exercises and discussions. According to constructivist learning theory (Piaget, 1968; Vygotsky & Cole, 1978), these activities stimulate active learning. Constructivist learning theory encourages educators to create opportunities for students to construct their own knowledge rather than passively receiving information in a traditional classroom setting.

The flipped classroom builds on technological developments that have impacted higher education, introducing new methodologies and innovative tools. This development has coincided with a shift from teacher-centred to student-centred teaching and learning, with technologies facilitating a transition from traditional lecture-based methodologies to more learner-centred approaches using online platforms and various technological devices (Estrada et al. 2019). In recent years, university teachers have been compelled to adopt online teaching due to COVID-19 pandemic lockdowns. A recent report by Barnes and Noble College (2022) concludes that after COVID-19, "higher education has been changed forever, and students and institutions are now on the path to prepare for a post-pandemic future" (p. 2). However, during the pandemic, the flipped classroom was based on the "replacement model" (Auster, 2016), where face-to-face, in-class meeting time was replaced with online, out-of-class learning activities, as well as the online delivery of course content. In contrast, for this study, we decided to apply the "supplemental model" (Auster, 2016), where the same amount of in-class meeting time is retained, but technology is incorporated into activities outside the classroom. For this purpose, each one of us conducted an "intervention" in our respective course where we substituted a traditional class with one that uses the same basic structure, but where students are asked to watch instructional videos or engage in other online activities outside of class time. The idea is that the video and online activity outsource parts of the often lengthy monological lecture format to a shorter virtual format that supports students in their preparation, thus allowing more classroom time to be dedicated to interactive learning activities such as exercises and discussions. Our aim was to explore the potentials and pitfalls of this model, particularly in a specific context that focuses on problem-based learning. To this end, we implemented it as an experiment in teaching where we not only take the role of the teacher to gain first-hand experience with the method, but also the role of a researcher that observes and draws conclusions. As teachers, we report on the lessons we learned with respect to implementing the model from a teacher's standpoint. As researchers, we asked students to fill in survey questionnaires, conducted peer observations of each other's classes, and used reflexive notetaking during the process. Thereby, this study seeks to specifically examine the effect of flipping the classroom on students' engagement, which is known to be strongly correlated to positive outcomes of student success and development (Trowler, 2010). What made this experiment particularly interesting to us is that due to the diversity of our backgrounds, our interventions spanned different teaching formats and disciplines across the social and natural sciences. Our findings suggest that despite potential downsides to implementing the approach, the flipped classroom holds significant promise for enhancing active student engagement in higher education.

The remainder of this article is organised as follows. The next section provides an overview of the literature on the flipped classroom model we considered for our study. After that, we describe how we applied it to our own teaching practice. The section that follows presents our data collection methodology, after which we present, and then discuss, the results we obtained. Then we conclude.

Literature on the flipped classroom

Research on the flipped classroom highlights how the model can provide a good balance between self-regulated pre-class learning through video materials, required readings to achieve comparable levels of pre-knowledge, and in-class activities incorporating collaborative learning (Goedhart et al., 2019). This has been shown to positively influence student engagement, particularly within a diverse group of students (Goedhart et al., 2019). The flipped classroom is intended to improve the efficacy of classroom learning by moving some of the lecture-based teaching, typically characterised by one-way communication from teacher to students, to the student's online preparation. This move allows students to control the timing and pace of their online learning, thereby maximising time and opportunities for active learning through discussions and collaborative exercises in class. The dialogical dynamics of enhancing time for in-class discussion and collaborative exercises are also believed to facilitate teachers' understanding of student learning (Mok, 2014). Furthermore, this model has the potential to enhance student engagement as well as learning outcomes. The student's active engagement in discussions and exercises in class enhances the teachers' possibilities for providing more direct feedback to the students in relation to concrete topics. By enhancing the possibilities for learning differentiation, the combination of online learning and the in-class exercises further has the potential to increase inclusion of all students and their needs and decrease university drop-out rates. The ideal is that the model creates a more participative and dynamic classroom atmosphere facilitating all students' engagement and learning (Mingorance Estrada et al., 2019; Goedhart et al., 2019).

However, the flipped classroom approach also presents challenges regarding the workload of both students and teachers, as well as a cultural shift that necessitates different roles and modes of engagement. Student preparation is a critical factor for successful engagement and learning in flipped classrooms, both inside and outside the classroom (Lai, 2021). Additionally, the preparation of pre-lecture material by university teachers before the course begins can be time-consuming; however, as Tate et al., (2018) argue, this burden may be mitigated throughout the term, as less preparation is required during the course. Another concern is that flipping the classroom may contribute to a counterproductive increase in students' preparation time, particularly affecting struggling students. Similarly, university teachers already face increasing workloads, and the demand for flipped classrooms could potentially exacerbate this issue (Lo, 2017).

Particularly relevant when connecting this model to the educational context of Roskilde University, some research highlights the benefits of combining problem-based learning with the flipped classroom (Chis et al., 2018; Lai et al., 2021). While problem-based learning does not directly equate to the specific educational model at Roskilde University known as problem-oriented project learning (PPL), similarities exist, such as their problem-orientation and focus on student-driven learning. PPL is based on student-driven learning, which means that the students are expected to participate actively and enthusiastically in the learning processes at Roskilde University. Student-driven learning is particularly evident in the problem-oriented project work that constitutes a key element of PPL. Chis et al. (2018), based on their study from a programming course, suggest that a flipped classroom is more effective when combined with a problem-based learning model, as measured by students' performance, particularly in learning skills such as problem-solving and self-direction. However, Roskilde University's educational programmes are already heavily blended; 50% of the education consists of student-led project work and traditional lectured-based learning is limited to 50% or less. This may limit the potential of the flipped classroom in courses, as both students and teachers might feel a need for traditional lecturing (i.e. teacher-led learning activities). Literature has addressed the challenges of cultural and practical changes in higher education (Tate et al., 2018). For the flipped classroom to realise its potential, active engagement from both teachers and students is necessary, along with an openness to challenge established habits (Tate et al.,

2018). Flipping the classroom in conjunction with student-led project work might be perceived, at least at Roskilde University, as placing too much responsibility on the students. However, given the recognised importance of active learning and constructivist learning theory for successful higher education (Erbil, 2020), implementing the use of the flipped classroom approach in Roskilde University courses could boost student engagement, particularly in those that are not inherently student-led or problem-oriented.

Flipped classroom experiments as a method: our pedagogical aim and specific approach

Inspired by the academic literature on the flipped classroom (Hawks, 2014; Erbil, 2020, Lai et al. 2021; Mingorance Estrada et al., 2019), this section describes how we have interpreted and applied the flipped classroom approach. Our pedagogical aim has been to explore possibilities for increasing students' engagement in their own learning by introducing a new teaching method. According to constructivist theories on active learning methods, the student takes an active role as the "constructor" of their own knowledge (Piaget, 1968; Vygotsky, 1978). As stated elsewhere, the approach "represents a unique combination of constructivist ideology and behavioural principles that can be used to bridge the gap between didactic education and practical performance" (Hawks, 2014). Teacher-led didactic education is partly brought out of the classroom, and in class, the students' practical performance is the focus. As such, the learning theory behind our flipped classroom interventions is that students learn through the social interactions they engage in with peers and teachers, by learning content "directly through primary experience, by doing and living, and internalising it" (Vygotsky, 1978). Students' engagement is central to this learning theory, and following Trowler (2010), we understand engagement to have behavioural, emotional, and cognitive dimensions, which we will present in more detail below. To explore the pedagogical aim of increasing students' engagement, we conducted five interventions (see Box 1) in our own teaching based on the flipped classroom.

Box 1: The five interventions and their context

Essential Computing: This intervention was implemented in a foundational computing course. In addition to standard readings from the textbook, students were required to view two 30-minute videos and engage with pre-posted exercises while submitting potential questions in an online forum. The videos introduced students to the programming concepts of methods and conditionals, both at a conceptual level and through examples, replacing what would have been a 90-minute traditional lecture within a 4-hour weekly class. Consequently, class time was dedicated to collaborative problem-solving on a larger programming exercise about the newly introduced concepts. The interactive format fostered real-time engagement and support, creating a conducive learning environment. Although registration included 42 students, physical attendance averaged around 30, potentially due to the option for remote completion of assignments.

Chemistry: The intervention was applied in a lecture about basic chemistry. The flipped lectures utilised a compendium of chapters, with a 30-minute video lecture directly reflecting the content of the compendium. Alongside this, exercises were prepared, and an online question forum was established to enhance student interaction. Notably, the exercises were introduced with examples during the video lecture, facilitating the inclusion of more complex questions. During the on-site class, students worked in groups while ongoing support was provided, allowing for real-time gauging of understanding and targeted assistance.

The Sociology of Everyday Life: This intervention was conducted within an advanced social science qualitative methods course. Two out of a total of 10 classes were flipped. In the two flipped classes, the students were required to read two theoretical texts and view a 20-minute video lecture covering sociological theoretical concepts. The lecture was designed to convey the theoretical background, allowing in-class time for the sharing of research examples and engaging students in exercises to apply these concepts. An online forum was made available for students to submit questions and reflections, thereby enabling the teacher to address these questions during the in-class introduction. The complexity of the material was evident, as numerous questions arose concerning concepts previously explained. This highlighted the need for re-explanation, either due to the complexity of the concepts or due to the students' (lacking) engagement with the video.

Pragmatic Sociology: This intervention was conducted within an advanced social science methods course, focusing on qualitative critical methods. A flipped classroom format was adopted featuring a 20-minute video lecture for home viewing, complemented by three assigned readings. The content of the video was theoretical, explaining the historical background of the pragmatic sociology school. An online forum was established to pose reflection questions aimed at guiding students' comprehension of the texts and facilitating clarification queries that were addressed during class. The remaining time of the on-site class was spent on student-led exercises, supervised by the teacher.

Inequality of Education: The class focused on the theme of social inequality in educational outcomes and utilised three theoretical texts alongside one journal article as reading materials. In preparation for the discussion, students were instructed to engage with an audio-augmented slideshow outlining five descriptive questions pertaining to the article, which was intended to facilitate comprehension and enhance analytical discussions during group work, a so-called reading guide. This intervention exemplifies a low-degree implementation of the flipped classroom. The class adhered to the established course structure, including a 45-minute lecture, a 15-minute break, and a 45-minute discussion section including both group discussion and plenum discussions.

In all interventions, we moved some of the lecture-based teaching from the on-site class into the students'

preparation, leaving more time in class for group discussions and exercises. The students are still required to read the mandatory literature designated for the class. In some cases, the readings may be slightly limited in quantity or complexity compared to traditional classes, in order to avoid study overload. In four of the interventions (Essential Computing, Chemistry, The Sociology of Everyday Life, and Pragmatic Sociology), we provided the students with the opportunity to ask questions in an online forum prior to the in-class session. We introduced this element to enhance the students' active engagement and underline the participatory format of the interventions. The in-person classroom time (face-to-face) was (in most cases) split into two parts. In the first part, the questions posed in the online forum were addressed to ensure the students understood the concepts. The second part was devoted to interactive exercises, discussions, or group projects. (Figure 1).

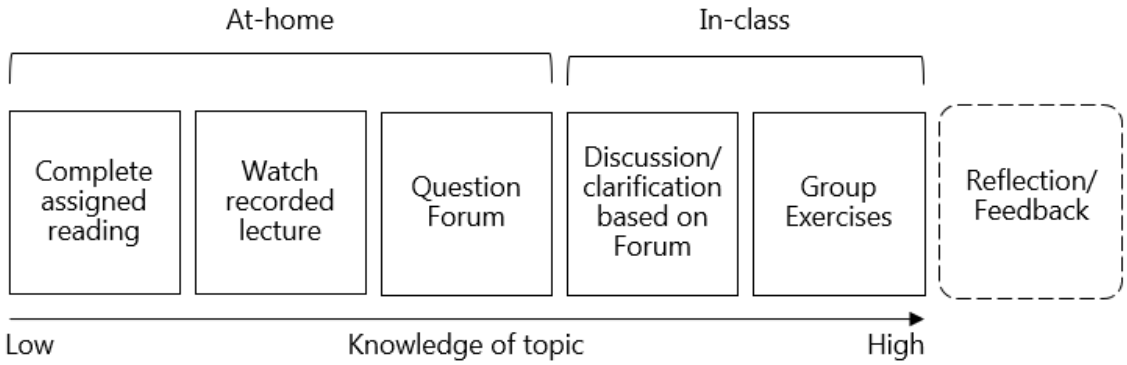

Figure 1. Visualisation of our flipped classroom design (based on Shiau et al., 2018). The arrow at the bottom of the figure shows the intended increase in students' knowledge on the topic of the class.

The design and extent of the interventions varied based on the context of the courses and the teacher's preferred style. Inspired by a study on the more general concept of blended learning (Alammary et al., 2014), the approaches can be distinguished as low-impact, medium-impact, and high-impact. Since we do not want to assume 'impact', we use instead the categories low-degree, medium-degree, and high-degree flipped classroom. In some cases, the class was more 'flipped' than in others, and Figure 2 shows the variety between our interventions, divided between the five classes they were embedded in.

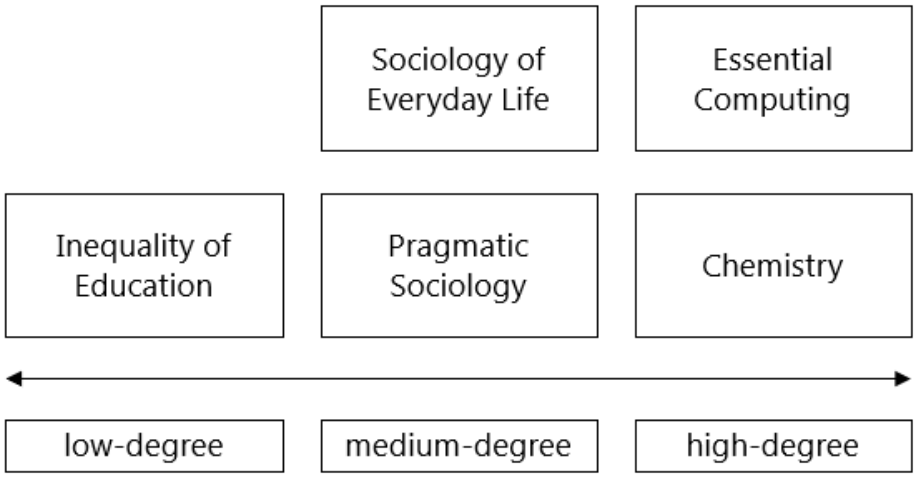

Figure 2. Degrees of flipped classroom of our interventions. The arrow in the bottom of the figure indicates

the degree to which the flipped classroom was implemented in each intervention: a low-degree intervention with a short reading guide, a medium-degree intervention with a mix of video lectures and on-site lectures, and a high-degree intervention with video lectures and no on-site lectures.

The high-degree model was implemented in the classes linked to natural science and computer science (Essential Computing, Chemistry), which made the interventions take the form of a more thoroughbred flipped classroom. Here, the entire on-site lecture was converted into video lectures, and, in class, the teachers concentrated on exercises. In class, the teachers only went through the exercises, and it was then up to the students to work with the material and content of the class. Common to Essential Computing and Chemistry is that the skills the students are expected to acquire are quite concrete (programming and problem solving, respectively), and the high-degree model that leaves more time for working with these skills therefore seemed appropriate.

The medium-degree flipped classroom was implemented in the two sociology classes, which had shorter video lectures and spent around half of the time in class in a form of lecture format (however based on questions from students). Both the intervention Sociology of Everyday Life and the intervention Pragmatic Sociology supplied the students with video lectures of a little less than 20 minutes. Both Sociology of Everyday Life and Pragmatic Sociology are qualitative methods courses, however in both courses the methods are linked to quite comprehensible theoretical concepts necessary for the students to learn to be able use the methods. In both interventions, the aim was for the students to be able to put the theoretical concepts into use, thus interventions based on the medium-degree model, where some of the in-class time was still spent on the basic theories, seemed suitable.

The low-degree approach was implemented in the intervention Inequality of Education. Here the students were provided with an 8.5-minute video lecture containing a reading guide and not a lecture as such. The video lecture advised the students regarding what to focus on in the readings in order to be well prepared for the class exercises and discussions.

Data collection methodologies in evaluating flipped classroom experiences

To document experiences from our experiments with the flipped classroom, we produced three sources of data, with the intention that we capture the points of view of both students and teachers as the parties being involved in teaching, as well as an "outside" perspective. To this end, each author acted as a teacher implementing their own flipped-classroom intervention and as a researcher assessing their own and other authors' interventions (see the Analytical strategy below). First, to get some insights directly from the students themselves, we conducted a survey among the students attending the five intervention classes. At the end of the class, the students were asked to answer three questions anonymously; two questions ("I felt engaged in the topic of today's class", "I got something out of this class") with a fixed Likert scale answer category ("strongly agree", "agree", "undecided", "disagree", "strongly disagree", "don't know") and one open-ended question ("What activity made you feel particularly engaged during today's class or during your preparation for the class? Write as much as you like"). The way the questions are posed may have created a social desirability bias (Miller, 2011), where answering that one does not feel engaged and/or has not learned something, and thereby assessing oneself as unengaged, is unlikely. The answers to the open-ended question gave us insight into which activities related to the class the students felt most engaged in. The questionnaire was completed by 9 students in "Inequality of Education", 22 students in "Sociology of Everyday Life", 8 students in "Pragmatic Sociology", 2 students in "Chemistry" and 15 students in "Essential Computing". Second, to produce qualitative data on the students' engagement and learning that removes some of the subjectivity of the participating teacher and

students, each flipped classroom intervention was peer-observed by another author of this study as an external observer. The observer used an observation protocol (Smith et al., 2013) with predetermined categories and attention points, recording for instance the fluctuations of energy levels, the teacher's and students' activities, general mood, etc. The observations provided qualitative data on the interaction in the classes and how this relates to the activities, for instance the students' engagement in exercises as this excerpt illustrates from the observation notes from the Essential Computing class: "During the group individual/exercises, they engage more emotionally both in talks with each other and with the teacher and the tutor. Showing both interest and some amount of enjoyment." Third, after having taught the class, the teacher took notes about their own experiences of the interventions in terms of the teacher's experience of organising the flipped classroom intervention, and the teacher's experience in class including the teacher's feelings in relation to and assessment of the students' engagement and learning. We refer to these notes as reflexive since the purpose was for the teacher to reflect on their own practices rather than record exactly what happened in the classroom. Ideally, we would have liked to draw on formal evaluations of the courses to make systematic comparisons over time, between interventions, and between classes with and without interventions. However, at Roskilde University, formal evaluations are only carried out every 6th semester when deemed necessary by the study board, and hence this data source was not available. Moreover, formal evaluations typically do not ask the students how engaged they felt during class or at what point during the preparation and the class they felt most engaged.

Analytical strategy

Since we conducted the five interventions as part of our training programme for early-career university teachers, we chose an analytical strategy supporting the individual teachers' reflexive process. First, each author analysed the survey data, peer-observation notes, and their own notes relating to their own intervention. The analysis focused on identifying the three aspects of engagement or the lack thereof (Trowler, 2010). Each author summarised the results related to their own intervention in a document and shared this with the rest of the authors. Based on these individual analyses, we convened to discuss differences and similarities across the five interventions.

Results

The analysis focuses on students' engagement from a behavioural, emotional, and cognitive perspective (Trowler, 2010). Behavioural engagement refers to the students' concrete behaviour, e.g. whether they attend lectures and participate with enthusiasm, and to what extent they comply with behavioural norms, judged by the absence or presence of disruptions as an example. Emotional engagement refers to the students' affective reactions, e.g. interest and enjoyment instead of boredom and rejection. Cognitive engagement refers to the students' engagement in terms of how interested and invested they are in their learning, e.g. how they meet assignment requirements, such as the manner and extent to which they complete class exercises (Trowler, 2010). Table 1 gives an overview of which data collection method we used for the different types of engagements, as well as what findings we could draw. Details are given below.

Type of engagement	Type of data collection	Findings
Behavioural (Preparation)	Teacher's notes (direct conversation with present students; access statistics for videos and class materials on e-learning platform).	Inconclusive due to indirect nature of data collection, but it appears most students did the preparation.
Behavioural (Attendance)	Teacher's notes (counting present students at beginning of class).	Unaffected by flipped classroom.
Behavioural (In-class)	Questionnaire; peer observation.	Students self-reported positively to feel engaged. Observation showed students to be generally attentive.
Emotional	Questionnaire; peer observation.	Students expressed some frustration with the provided materials. Students self-reported, and observations showed that emotional engagement is low during lectures, but higher during exercises and discussions.
Cognitive	Teacher's notes; peer observation.	Difficult to assess. Observations indicate cognitive engagement being limited to few students during lectures, but more widespread during exercises and discussions.

Table 1: Overview of data collection and findings by type of engagement according to (Trowler, 2010)

Students' preparation

Part of students' behavioural engagement is to prepare for class. Students do not have infinite preparation time, so time spent watching a video lecture should, in principle, reduce time spent reading. Consequently, having added a video to the students' preparation, the teacher is encouraged to reduce the amount of required reading. The didactic idea is that "less is more": learning by constructing knowledge during group exercises means learning more deeply about a smaller amount of content as opposed to learning more superficially about a larger amount of content by attending a lecture.

We only have limited insight into what fraction of the students did the preparation they were asked to do. In the course on Inequality of Education, half of the present students (8 out of 16) had watched the video reading guide and read the journal article. For the Chemistry course, the video had been watched 16 times (with 14 students enrolled in the class), where one student confirmed verbally that they had watched the first part of the video before the lecture. The supposition that most students did the preparatory work is supported by the indirect observations of a majority being active in an online forum connected to the course before the class (Essential Computing) and about ten to twelve students engaging with online questions to the readings prior to the class (Sociology of Everyday Life). On the other hand, only a few students made use of the possibility to pose questions in the online forums in advance of the class, e.g. four in the case of Pragmatic Sociology.

While our data do not allow us to assess whether the interventions increased or decreased students' preparation, our general impression is that most, but far from all students, did the preparations.

In-class attendance

A basic element of behavioural engagement is to show up for class. Across the five interventions, around 50% of enrolled students showed up for class (Inequality of Education: 16 out of 30 students, Essential Computing: 24 out of 42, Chemistry: 7 out of 14, Pragmatic Sociology: 14 out of 34, The Sociology of Everyday Life: 23 out of 46). In these classes, attendance is not mandatory nor monitored. In our experience, an attendance rate of around 50% is common. Hence, we do not think that the flipped classroom approach affected attendance. However, one may speculate that the video lectures might have led some students to stay away from the class. Students might have thought that the video lecture was replacing the on-site lecture, or they may not have viewed the video lecture and were concerned they would be unable to follow the class. We suggest teachers address these concerns in their communication leading up to the class by emphasising the importance of the on-site class.

Students' behavioural engagement in class

The vast majority of the students gave very positive responses in the questionnaire, replying that they felt engaged and that they had learned something. Generally, the students across the interventions complied with the norms in the sense that they were quiet during the lectures, stayed in their seats, and did not interrupt. During the lecture, most students were attentive and taking notes (Sociology of Everyday Life, Pragmatic Sociology, Essential Computing, Inequality of Education). However, some students also seemed to zone in and out, thus indicating lower behavioural engagement.

However, as the expectations for preparation were not met by all students, the discussion parts were at times difficult. Since the classes were designed on the assumption that the students showed up well prepared, the lack of preparation affected the in-class behavioural engagement of some students. In one intervention, this issue required some improvisation: the teacher guided and scaffolded a group of unprepared students in order for them to be able to do the exercise (Inequality of Education) (van de Pol et al., 2010). This experience highlighted the need to address students' preparation by dividing students into groups of prepared and unprepared students. In this way, prepared students can do the exercise, while unprepared students can familiarise themselves enough with the topic in order to follow the plenary discussion afterwards.

In another intervention, the questions that students had posted in the online forum were answered in the video lecture that they were supposed to have seen (Sociology of Everyday Life). The teacher began the class by answering these questions. The problem with targeting the unprepared students is that it might distract the well-prepared students and lower their incentive to prepare for future classes.

Most likely, some on-site lecturing is necessary, especially if the on-site lecture focuses on examples and the application of theoretical concepts. In the intervention without any on-site lecture, some students suggested that an introductory lecture would have made the start-up of the on-site group discussion and exercises easier (Chemistry).

Students' emotional engagement in class

Emotional engagement refers to students' affective reactions (Trowler, 2010). We assessed these affective reactions in our observations and in the student survey. A few students displayed negative emotions. One student found the texts too difficult and was also critical of one of the examples. This led to an interesting discussion with the teacher on the example provided (Sociology of Everyday Life). Some students expressed frustration in relation to the quality of the video lectures (Essential Computing, Chemistry). One student

expressed that the provided reading guide enhanced their motivation for reading (Inequality of Education).

From the observations, it is clear that the energy level in class was low during the lecture parts of the classes, whereas it rose during the exercises. This corresponds with the open-ended questions where several students across the interventions answered that they liked and felt engaged during the exercises. Several students also stated that they liked the balance between lectures and exercises, thus indicating that this produced emotional engagement. The exercises furthermore gave space for interaction between students, and we observed that these interactions included emotional engagement in terms of affective reactions to the topics. In addition, the interaction between the teacher and students during the exercises produced emotional engagement, where students asked questions and engaged in discussions with the teachers, expressing positive emotions. In terms of the teachers' emotional engagement, the video provided the chance for the teacher to display excitement already before the class in a way that would not be possible in, e.g., a written reading guide.

Students' cognitive engagement in class

In our interventions, cognitive engagement is difficult to assess. However, the observations and the teacher notes indicate that students' cognitive engagement varied quite a lot within the student groups. Particularly during the lecture parts, a small number of students displayed a high level of cognitive engagement, answering questions posed by the teacher and asking sophisticated questions, whereas the majority of students did not answer nor ask questions during the lectures. In the exercises, more students engaged cognitively, discussing the topics with each other and the teacher. Some students said directly to the teachers that they had learned something important (Pragmatic Sociology, Chemistry). Getting more feedback from the students, e.g. from a quiz or active use of student presentations, would perhaps have given us more information on their cognitive engagement.

Summary

The findings indicate that while students' emotional engagement was enhanced through on-site discussions and group exercises, their behavioural engagement – encompassing preparation for class, attendance, and classroom behaviour – appeared largely unaffected by the flipped classroom model. Despite the assumption that flipped learning would boost cognitive engagement during collaborative exercises, the evidence remains inconclusive, as variations among student engagement levels were observed. While it makes sense to maintain a theoretical division between behavioural, emotional, and cognitive engagement, we also find that, in practice, these aspects overlap and are sometimes so connected that they are hard to spot separately. The analysis underscores the importance of balancing preparatory tasks to avoid overwhelming students and suggests that effective communication about the role of on-site classes may alleviate concerns regarding attendance. Overall, the potential for increased cognitive engagement through active learning remains a promising avenue, but additional measures, such as feedback mechanisms, could provide a clearer understanding of students' cognitive engagement in future iterations.

Discussion

Our interventions and analysis indicate that the flipped classroom approach can be beneficial for student engagement and learning outcomes. Specifically, we found that substituting traditional lecture time with interactive activities, such as exercises and discussions, significantly enhances students' emotional engagement with the material. Additionally, the process of designing and preparing for flipped classroom lessons led to the creation of valuable resources – such as instructional videos – that students find helpful for exam preparation and can reference long after the course has concluded.

However, there are also some pitfalls and challenges to consider. For one, the exact implementation of the flipped classroom varies considerably across different disciplines, programmes, and levels of study. For example, academic readings play a central role in the social sciences, but less so in basic courses within technical fields. Thus, a resource in the form of a reading guide makes sense for the former but not so much for the latter. A more hands-on technical instruction worked well for the videos in the Chemistry and the Essential Computing classes, where the videos in the social sciences focused on theoretical concepts. It is therefore impossible to design a flipped classroom according to a boilerplate recipe; it requires that the teacher takes the specifics of their field, class, target student group, etc., into consideration.

Furthermore, creating the resources used by the students in their preparation, particularly videos, requires the teacher to invest a certain amount of time and effort. The preparation time for the flipped classroom lectures (90 minutes) was around 15 hours for each teacher, which is well over the seven hours granted for preparing a class (which includes two hours of class). The lectures chosen for the flipped classroom approach were new to all of us, so no teaching material was available from previous years. The preparation and recording of videos particularly added to the preparation time. We also spent extra time designing exercises for the class.

Here, it should be kept in mind that while the videos should adhere to some standard of quality, the law of diminishing returns applies; at some point, a further increase in the video's quality has little to no additional effect on the desired outcome in terms of the students' engagement and learning. As with most new teaching methods, it will be less time-consuming over time when running the course consecutively (Tate et al., 2018). Moreover, the reusability of videos should be considered right from the start; for example, it creates considerable additional effort to edit out specific remarks about the current semester's class schedule, exam dates, etc., and hence those should be avoided. It is also recommended to avoid making long videos, but instead break topics up into smaller parts to be more flexible in whether and when to use the different parts in the future. For the creation of videos, for some it worked well to have prepared manuscripts, in order to avoid too many mistakes while recording.

Another aspect where it is important to strike the right balance is in terms of how much material should be provided to students. There is a risk of overcrowding the curriculum (Slavin & D'Eon, 2021), where the amount of additional material and lecture content may overburden students, again leading to counterproductive outcomes. In hindsight, some of us wondered whether we had asked the students to read too much (The Sociology of Everyday Life, Pragmatic Sociology, and Inequality of Education), or whether the sets of tasks were too complex, e.g. reading, asking questions in an online forum, watching a video lecture, and completing a homework exercise (The Sociology of Everyday Life). The aim should be to create a class that does neither ask for more nor less investment from students than a traditional one, but to replace some of the tedious parts, such as classical lecturing, with more quality-time activities that allow for a more in-depth exploration of examples and theory.

A related issue is that one should avoid too much micromanaging or spoon-feeding students, which may lead to frustration on both sides if things do not work out as planned. Instead, we found that the approach of scaffolding students' learning works well, for example, by means of the aforementioned reading guides. The idea is not to prescribe every single step the students must take but to provide them with just enough guidance so that they can reach their own conclusions and "aha" moments, thus increasing their motivation and overall emotional engagement. The use of an online forum to pose questions after watching the video and before meeting physically in class can be vital in this process of getting students actively engaged. A heuristic when creating flipped classroom activities is to aim at providing students with incentives to engage with the class

topics. For example, we observed that the reading guides sparked students' engagement with the readings, and that practical exercises that show a clear relation to the underlying theoretical concepts are beneficial to students' motivation. To overcome the risk that students do not attend class because of the existence of video lectures, teachers may need to develop other formats like group recap exercises.

Students' prior socialisation plays a crucial role: Are they accustomed to actively engaging during class or merely listening passively? At times when we hoped for more student engagement, their previous socialisation regarding classroom behaviour might have held them back. In some courses, the classes preceding the flipped classroom intervention followed a traditional lecture format (as did most of their previous university courses), which may have conditioned students to be passive recipients of knowledge rather than active constructors of it. Therefore, realising the full benefits of the flipped classroom may be as much a learning process for the students as it is for the teachers. This includes an additional need for metacommunication with the students and finding a way to clarify and match expectations around the changed role of students and teachers. Additionally, a limitation of our study is the lack of systematic comparison, as we do not have a control group with a traditional lecture format for direct comparison.

Conclusion

This study reviews the relevant literature on case studies of the flipped classroom and the underlying learning theories, informing the development of flipped classroom interventions for our courses during the Autumn 2022 semester at Roskilde University, spanning multiple disciplines, levels, and departments. Grounded in a constructivist theory of learning, we adopted a supplemental model of the flipped classroom, leveraging technology as an additional support tool outside the classroom. Although the interventions were tailored to suit specific courses, student cohorts, and study programmes, they consistently centred around the core concept of providing instructional videos to students prior to class, thereby creating additional time for interactive exercises and activities. We collected empirical material through student surveys, peer observations conducted by a group member, and reflexive note-taking throughout the intervention process. Our analysis of this data, while acknowledging its limitations – such as potential social desirability bias – reveals that our flipped classroom interventions enhanced students' emotional engagement and opportunities for active learning.

From the teachers' perspective, we noted that implementing the flipped classroom demands a considerable investment of time and effort for preparation. While this initial burden may seem daunting, we found the outcomes to be rewarding, particularly when applying a high-impact approach, as evidenced by the significant increase in student engagement. Furthermore, the necessary preparation time is expected to decrease in subsequent years as materials are reused and instructors gain more experience. We also identified several challenges, including the risk of overcrowding the syllabus, the pitfalls of overly guiding or micromanaging students, and the possibility of not executing the teaching plan as intended. These challenges, however, are not insurmountable; they largely require fine-tuning and the accumulation of experience over time.

Our recommendations include regularly soliciting feedback from students – either through digital tools or direct inquiries – and providing incentives for active engagement with class materials. While there are both advantages and potential downsides to implementing the flipped classroom approach in higher education, we posit that it holds significant promise for enhancing students' opportunities for active learning, particularly within the context of problem-oriented learning as practised at Roskilde University.

References

Alammary, A., Sheard, J., & Carbone, A. (2014). Blended learning in higher education: Three different design approaches. *Australasian Journal of Educational Technology*, *30*(4), Article 4. https://doi.org/10.14742/ajet.693

Auster, C. J. (2016). Blended Learning as a Potentially Winning Combination of Face-to-face and Online Learning: An Exploratory Study. *Teaching Sociology*, *44*(1), 39–48. https://doi.org/10.1177/0092055X1561921

Barns and Noble College (2022, November 28). *Emerging from the pandemic: Reimagining Higher Education*. https://www.bncollege.com/wp-content/uploads/2022/06/College-2030-Report-Second-Edition_6_24_FINAL_upload.pdf

Bergmann, J. (2012). Flip your classroom: Reach every student in every class every day. *International Society for Technology in Education*. https://books.google.com/books?hl=en&lr=&id=-YOZCgAAQBAJ&oi=fnd&pg=PR7&dq=Bergmann+J,+Sams+A+(2012).+Flip+your+classroom:+reach+every+student+in+every+class+every+day.+Eugene:+International+Society+for+Technology+in+Education.++&ots=AHffPKpopl&sig=LGeYBeAVZIG96NlBhksGGPs4gxQ

Chen, Y., Wang, Y., Kinshuk, & Chen, N.-S. (2014). Is FLIP enough? Or should we use the FLIPPED model instead? *Computers & Education*, *79*, 16–27. https://doi.org/10.1016/j.compedu.2014.07.004

Chis, A. E., Moldovan, A.-N., Murphy, L., Pathak, P., & Muntean, C. H. (2018). Investigating Flipped Classroom and Problem-based Learning in a Programming Module for Computing Conversion Course. *Journal of Educational Technology & Society*, *21*(4), 232–247.

Drozdowski, M.E.D (2022, November 28). *7 Challenges Threatening the Future of Higher Education. Best Colleges*. https://www.bestcolleges.com/news/analysis/7-challenges-threatening-future-of-higher-education/

Erbil, D. G. (2020). A Review of Flipped Classroom and Cooperative Learning Method Within the Context of Vygotsky Theory. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.01157

EEVA (2022, November 28). Højt fagligt engagement og stærk social tilknytning mindsker risikoen for frafald. https://www.eva.dk/videregaaende-uddannelse/hoejt-fagligt-engagement-staerk-social-tilknytning-mindsker-risikoen

Goedhart, N. S., Blignaut-van Westrhenen, N., Moser, C., & Zweekhorst, M. B. M. (2019). The flipped classroom: Supporting a diverse group of students in their learning. *Learning Environments Research*, *22*(2), 297–310. https://doi.org/10.1007/s10984-019-09281-2

González Velasco, C., Feito Ruiz, I., González Fernández, M. D., Álvarez Arenal, J. L., & Sarmiento Alonso, N. (2021). Does the teaching-learning model based on the flipped classroom improve academic results of students at different educational levels? *Revista complutense de educación*. https://doi.org/10.5209/rced.67851

Hadjerrouit, S. (2008). Towards a Blended Learning Model for Teaching and Learning Computer Programming: A Case Study. *Informatics in Education - An International Journal*, *7*(2), 181–210.

Hawks, S. J. (2014, August 1). *The Flipped Classroom: Now or Never? | EBSCOhost*. https://openurl.ebsco.com/contentitem/gcd:97344700?sid=ebsco:plink:crawler&id=ebsco:gcd:97344700

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, *38*(5), 758–773. https://doi.org/10.1080/03075079.2011.598505

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. *The Journal of Economic Education*, *31*(1), 30–43. https://doi.org/10.1080/00220480009596759

Lai, H.-M., Hsieh, P.-J., Uden, L., & Yang, C.-H. (2021). A multilevel investigation of factors influencing university students' behavioral engagement in flipped classrooms. *Computers & Education*, *175*, 104318. https://doi.org/10.1016/j.compedu.2021.104318

Lo, C. K. (2017). Examining the Flipped Classroom through Action Research. *Mathematics Teacher*, *110*(8), 624–627. https://doi.org/10.5951/mathteacher.110.8.0624

Miller, A. L. (2011). Investigating Social Desirability Bias in Student Self-Report Surveys. In *Association for Institutional Research (NJ1)*. Association for Institutional Research. https://eric.ed.gov/?id=ED531729

Mingorance Estrada, Á. C., Granda Vera, J., Rojas Ruiz, G., & Alemany Arrebola, I. (2019). Flipped Classroom to Improve University Student Centered Learning and Academic Performance. *Social Sciences*, *8*(11), Article 11. https://doi.org/10.3390/socsci8110315

MOK, H. N. (2014). Teaching tip: The flipped classroom. *Journal of Information Systems Education*, *25*(1), 7–11.

Piaget, J. (1967). On the Development of Memory and Identity. *Heinz Werner Lectures*. https://commons.clarku.edu/heinz-werner-lectures/19

Sarker, F., Davis, H., & Tiropanis, T. (2010, November 1). *A review of Higher Education challenges and data infrastructure responses*. International Conference for Education Research and Innovation (ICERI2010) (15/11/10 - 17/11/10). https://eprints.soton.ac.uk/271695/

Shiau, S., Kahn, L. G., Platt, J., Li, C., Guzman, J. T., Kornhauser, Z. G., Keyes, K. M., & Martins, S. S. (2018). Evaluation of a flipped classroom approach to learning introductory epidemiology. *BMC Medical Education*, *18*(1), 63. https://doi.org/10.1186/s12909-018-1150-1

Slavin, S., & D'Eon, M. F. (2021). Overcrowded curriculum is an impediment to change (Part A). *Canadian Medical Education Journal*, *12*(4), 1–6. https://doi.org/10.36834/cmej.73532

Smith, M. K., Jones, F. H. M., Gilbert, S. L., & Wieman, C. E. (2013). The Classroom Observation Protocol for Undergraduate STEM (COPUS): A New Instrument to Characterize University STEM Classroom Practices. *CBE—Life Sciences Education*, *12*(4), 618–627. https://doi.org/10.1187/cbe.13-08-0154

Steen-Utheim, A. T., & Foldnes, N. (2018). A qualitative investigation of student engagement in a flipped classroom. *Teaching in Higher Education*, *23*(3), 307–324. https://doi.org/10.1080/13562517.2017.1379481

Tate, M., Campbell-Meier, J., & Sudfelt, R. (2018). Organizational routines and teaching innovations: A case study. *Teaching in Higher Education*, *23*(7), 885–901. https://doi.org/10.1080/13562517.2018.1437132

Trowler, V. (2010). Student engagement literature review. *Higher Education Academy*. https://www.academia.edu/download/30908577/StudentEngagementLiteratureReview.pdf

van de Pol, J., Volman, M., & Beishuizen, J. (2010). Scaffolding in Teacher–Student Interaction: A Decade of Research. *Educational Psychology Review*, *22*(3), 271–296. https://doi.org/10.1007/s10648-010-9127-6

Vygotsky, L. S., & Cole, M. (1978). *Mind in Society: Development of Higher Psychological Processes*. Harvard University Press.

Yarbro, J., Arfstrom, K., McKnight, K., & McKnight, P. (2020, April 24). *Extension of a review of flipped learning Network/Pearson/George Mason University*. https://flippedlearning.org/wp-content/uploads/2016/07/Extension-of-FLipped-Learning-LIt-Review-June-2014.pdf.

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