The flipped classroom: design considerations and Moodle

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ABSTRACT
One of the novel ideas in teaching that heavily relies on current technology is the "flipped classroom" approach. 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 hypothesis is that there could be deep and creative discussions when teacher and students physically meet. This paper presents design considerations for flipped classrooms, and discusses how Moodle can facilitate communication and information sharing in such classrooms. Furthermore, it provides guidelines for supporting out-of-class instruction in the flipped model by using quizzes and feedback in Moodle, and comments on the potential to follow student use of resources by using Moodle reports. This paper concludes with a discussion of the opportunities and challenges when implementing the flipped model in a virtual learning environment (VLE) like Moodle.

Keywords - flipped classroom, virtual learning environments, Moodle, quizzes, feedback

I INTRODUCTION

Bonwell and Eison defined active learning as "…anything that involves students in doing things and thinking about the things they are doing." (Bonwell & Eison, 1991). Active learning therefore embraces different instructional models, in which learners are engaged in other activities than just listening – they are encouraged to read, write, discuss and be involved in higher-order thinking. One of the recent developments in teaching, which is also a form of active learning, is the flipped (or inversed) classroom approach (Abeysekera & Dawson, 2015; O'Flaherty & Phillips, 2015). 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 video casts and/or pre-class reading and exercises, while class time is mainly used for group work activities (Berrett, Mangan, Neshyba, Talbert, & Young, 2015). The hypothesis is that there could be deep and creative discussions when the teacher and students physically meet.

This teaching and learning approach endeavours to make students owners of their learning trajectories, and relies heavily on current technology. However, the literature has yet to discuss in detail the tools that can facilitate flipped classrooms (Bishop & Verleger, 2013). In this paper, I am going to share our experiences and considerations in using Moodle for implementing a flipped classroom in engineering mathematics (Triantafyllou, Timcenko, & Busk Kofoed, 2015). The paper presents design considerations for flipped classrooms, and discusses how Moodle can facilitate communication and information sharing in such classrooms. Furthermore, it provides guidelines for supporting out-of-class instruction in the flipped model by using quizzes and feedback in Moodle, and comments on the potential to follow student use of resources by using Moodle reports. This paper concludes with a discussion of the opportunities and challenges when implementing the flipped model in a virtual learning environment (VLE) like Moodle.

II BACKGROUND WORK

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 (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. Strayer compared a flipped statistics class with a traditional one (Strayer, 2012). 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 (Kellinger, 2012; Nielsen, 2012). 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 (Chiang & Wang, 2015), while the holistic flipped classroom has teachers offering synchronous support to students both in and out of the classroom (Chen & Chen, 2014).

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 (Abeysekera & Dawson, 2015; O'Flaherty & Phillips, 2015). In our research in the Media Technology Department, we have adopted the flipped classroom instructional model inspired by the Problem-Based Learning pedagogy, which Aalborg University applies to all its programs. The next section discusses this theoretical framework, which we employed for designing the flipped classroom and the related out-of-class and classroom activities.

III PROBLEM-BASED LEARNING AND THE FLIPPED CLASSROOM

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).

The research presented in this paper is 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-centred 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).

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.

Additionally, 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.

Therefore, 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 justified by the aforementioned principles of 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-class instruction and then come into class, where groups of students engage in group activities facilitated by the teacher. 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 following section presents design and implementation considerations for a flipped classroom based on the experience of implementing the flipped instructional model in the Media Technology Department.

IV DESIGN AND IMPLEMENTATION OF A FLIPPED CLASSROOM

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. After class sessions, students may need to reflect on their practice or complete assignments given during class time. Figure 1 shows the flipped classroom framework. As literature has discussed, this generic framework allows for many different implementations depending on different class designs (Bishop & Verleger, 2013). In the following, several design considerations for each phase of a flipped classroom are discussed.

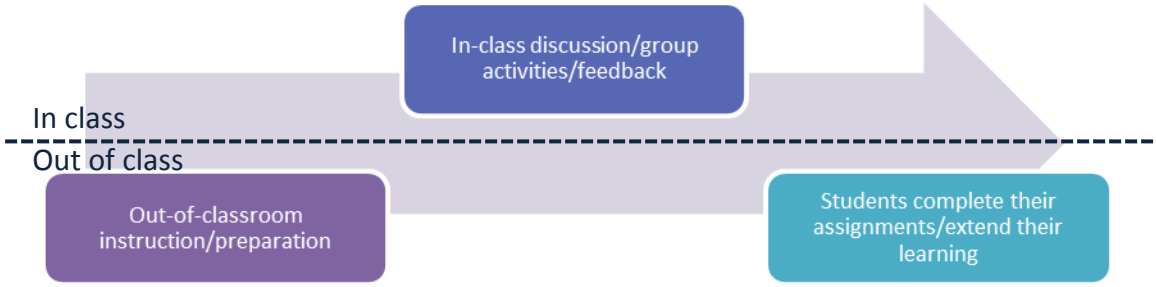

Figure 1. The flipped classroom framework

Out-of-class instruction

Instructors who wish to flip their classrooms should first decide how to distribute the learning process in the three phases of the flipped classroom framework. Initially, it is important that they consider which part of the lecture can be accomplished best online, which part can be accomplished best in class sessions, and possibly which part after class. When this distribution is done, instructors should decide how content can be delivered to students outside of class in meaningful ways. Educators have been employing different tools in order to deliver material out of class. Examples include problem-solving sessions as pencasts,

screencasts, parts of lectures as vodcasts (video podcasts), reading, online resources, and illustrations. Finally, they should implement the material for out-of-class instruction.

Another important aspect of out-of-class instruction and preparation is how to support students to self-regulate their learning and how to motivate students to complete their pre-class assignments. For supporting students during their self-paced learning, educators have employed feedback forms, online chats, forums among others. Such tools allow also teachers to adopt the in-class activities to students needs and difficulties. In order to ensure that students come to class prepared, instructors have used exercises, (online) diagnostic tests, and (obligatory) hand-ins. A more detailed discussion on out of class instruction can be found in (Triantafyllou & Timcenko, 2015).

Class sessions

Since at least a part of traditional lectures is transferred out of class, the class sessions shall be also reorganized. First of all, it should be considered how much time should be allocated on hands-on learning activities, how much time on lectures (if any), and what should be the teacher's role in the class. Moreover, in-class activities should be designed with the aim to encourage meaningful learning and engage students, and they should be integrated with out-of-class activities for optimal learning. On the practical side, it should be also considered if and which tools are necessary to use in order to support this new learning environment in class.

Research has shown that an important consideration for instructors is how to handle students who come to class unprepared. Ill-prepared students cannot participate meaningfully in class practice, and this can be very frustrating for their peers, especially when learning activities are carried out in groups. The solution to this problem depends heavily on the educational level where the flipped instruction model is applied, since there are different expectations depending on student age. Possible solutions include assigning different activities to ill-prepared students or requiring them to carry out the out-of-class preparation in class.

After class

After class sessions, the instructors may choose to require students to carry out supplementary activities. Post-class activities could be a continuation of what was done during class time (e.g. finalize in-class activities) or additional activities. In this case, activities may be used in order for students to check their understanding and/or reflect over their own practice. Finally, educators should decide if student assessment is affected by the new instructional approach. For instance, they should consider if diagnostic tests and in-class assignments are part of the assessment. If this is the case, then they should also consider how students are assessed based on such activities and how ill-prepared students are handled.

The flipped classroom in Media Technology

In the Media Technology Department, the flipped classroom was implemented for several mathematics-related courses. Regarding out-of-class instruction, pencasts, vodcasts, reading, and online resources have been employed for different implementations, and diagnostic tests were used in order to encourage students to complete their out-of-class preparation. During class sessions, group activities, feedback sessions and lecturing have been used for completing the learning process. Ill-prepared students were asked to study the online material, if they could not follow the class activities. Finally, students were required to upload their in-class activities after class, in order for the teachers to check their progress. Both diagnostic tests and in-class activities were part of the assessment. The communication between students and teachers and information exchange were facilitated by Moodle (Dougiamas & Taylor, 2003). Moodle is a learning platform designed to create personalised learning environments and is used by all programs at Aalborg University. The following section reports parts of this learning platform, which can be used for facilitating a flipped classroom.

V MOODLE AND THE FLIPPED CLASSROOM

Moodle is a VLE that acts as a communication channel between teachers and students. The simplest use of Moodle is information sharing, such as file-sharing, calendar, and announcements. It is therefore a platform for information exchange (e.g. sharing of vodcasts and reading material) in flipped classrooms. Apart from that, Moodle can provide information to teachers and host educational activities, which are also relevant for flipped classrooms. In the following, two Moodle activities are presented and their application on flipped classrooms is discussed. The information mentioned in this paper refers to Moodle's version 2.

The Moodle quiz

The Moodle Quiz allows teachers to design and build quizzes consisting of various question types, including multiple choice, true-false, essay, matching, etc. Questions can be randomly selected from question pools already created in Moodle and they can also be imported from other sources, e.g. various formats that book publishers use and text files. The teachers are also able to shuffle the questions in a quiz, if desired. Therefore, it is applicable to a wide range of subjects, allowing for various types of questions and answers.

The Moodle's quiz module has a large number of options that make it extremely flexible. Teachers are able to set time limits for an attempt to be completed, and also open and close dates and times for the quiz. This option allows teachers to be sure that diagnostic tests are taken and submitted before the class in the flipped instruction model. Moreover, teachers are able to enter feedback both for each answer (either correct or wrong) and also general feedback, when the attempt is complete. Feedback can guide students while trying out the quiz or between subsequent attempts, if this is allowed. By providing feedback adapted to each student's answers, teachers can support students during out-of-class instruction and also monitor comprehension and provide just-in-time explanations. Moreover, they can include in the in-class activities topics, which students found challenging based on the quiz results. Finally, students can self-regulate their learning, since they can check the correctness of their answers, and the knowledge that they are expected to have before class.

Regarding assessment, Moodle allows the teacher to assign point values to each question and weight each question in the quiz. Moreover, teachers may award partial credit to other answer choices (apart from the correct one), if desired. Finally, teachers may give individual students a different open/close period, time limit and/or number of attempts than the rest of the class. These features provide customization options to teachers that may be needed in out-of-class learning environments.

The Moodle feedback

The Moodle feedback activity allows teachers to create student surveys. It has several features that make it adjustable to different purposes. First of all, responses can be anonymous, and it is possible to allow more than one submission per person. Moreover, it is possible to define an open/close period and to request feedback in different forms (e.g. multiple choice questions, text answers, numeric answers). Finally, it is allowed to have branching questions, i.e. questions that only display if the user answers another question in a certain way.

The feedback module is ideal for requesting feedback on the out-of-classroom activities (pre- and post-class), but it can also be used to stimulate students to brainstorm or sharing ideas on any other related topic (e.g. what was the most interesting thing you learned today). Moreover, it allows students to send questions they may have during out-of-classroom preparation, possibly alleviating the feeling of lacking just-in-time explanations. The feedback activity in Moodle can also be employed to gather student opinions on the course as a whole or on specific topics, activities or aspects within it.

Moodle reports

Moodle can generate reports for each course. Reports can contain a) a log of activity in a Moodle course for various periods, b) a course activity report, showing the number of views for each activity and resource, c) a participation report for a particular activity, and d) graphs and tables of user activity. The Moodle reports allow teachers to know you what students have been doing in their Moodle courses. For example, they can get information on which pages they are accessing, the times at which they access them and the activities they perform there.

In a flipped classroom, reports can be a valuable tool for the teacher, since a huge amount of information is provided to students online. By using reports, teachers are able to alert students or improve navigation to course material they are neglecting, in order to make sure that they take full advantage of all the online resources provided. Moreover, they can adjust the course to suit students' viewing habits. Finally, course activity reports can be used to get insight on student participation and engagement in a flipped classroom.

VI DISCUSSION AND CONCLUSION

In this paper, we have discussed various design considerations for flipped classrooms and we have mentioned features of a VLE, i.e. Moodle that can be used to support such classrooms. Quizzes can serve as motivation and self-control tools for students during pre- or post-class activities. Moreover, they allow teachers to get insight into students' common mistakes and adjust their class sessions accordingly. Feedback activities (i.e. surveys) can stimulate students to reflect on their own practice and also to post questions to the teacher before or after class. Moreover, they can serve course evaluation purposes, by gathering student opinions and experiences. Finally, Moodle reports provide teachers with usage data and activity logs, which are useful for checking student behaviour during out-of-class time and improving the way information is transmitted. There can also be valuable course evaluation tools.

However, the implementation of a flipped classroom in Media Technology has shown that there are also challenges, when a VLE is used as a communication channel between teachers and students. Initially, there were problems uploading instructional videos in Moodle and also issues with videos in Moodle playing only once. These problems demotivated students and created confusion among them (Triantafyllou et al., 2015). Moreover, the literature and our experiences indicate that students do not use Moodle as a communication channel but mainly perceive it as a repository of learning materials, despite its great potential (Costa, Alvelos, & Teixeira, 2012). It is therefore recommended that educators, who aim at implementing flipped classrooms in Moodle, introduce the possibilities of this environment to students and provide clear guidelines on how it will be integrated to the new instructional model.

This paper has discussed opportunities and some challenges of using Moodle in flipped classrooms. It has been shown that this VLE can support student and teacher practice in such classrooms and it can facilitate communication between them. However, limited student use of Moodle and technical problems may hinder the acceptance of such tools. It would be therefore interesting for future research to investigate how teachers and students experience such learning environments in flipped classrooms, and which factors are decisive for creating positive attitudes towards their use.

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