DESIGNING FLIPPED LEARNING IMPLEMENTATIONS FOR ELECTRONICS COURSES

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ABSTRACT

Due to the COVID-19 pandemic during year 2020 many higher education institutes were forced to switch to remote teaching on a very short notice. The rapid change from on-campus to remote teaching showed us that effective remote teaching needs totally new forms of course implementations. The idea that one just moves the on-campus teaching to a distance learning platform without changing anything else was found to be inefficient and passivating for students.

Flipped Learning Method (FLM) has been successfully utilized in many fields, including engineering education. The students' learning is enhanced and deepened when they study the basic concepts of a subject remotely in the place and time that suits them, and the face-to-face time is reserved for issues on the higher levels of Bloom's taxonomy. In engineering studies, the possibility to utilize technology and technological tools are important. Nowadays the technological tools, such as the internet, simulation devices and various pieces of software, are widely available to students thus enabling and supporting the FLM.

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The FLM has been taken into use during couple of recent years in Tampere University. The COVID-19 situation gave us a trigger to adopt FLM in our courses. We believe that FLM is very suitable to hybrid teaching, where remote and on-campus teaching are combined in the same course implementation. In this paper, we will report our experiences on the rapid change to remote teaching on year 2020, the reasons for taking FLM into use, and the FLM planning and designing process of our courses.

1 INTRODUCTION

The COVID-19 epidemic meant a huge leap into remote teaching for educational institutes. Even after the COVID-19 many institutes are going to offer an increasing number of courses that utilise hybrid teaching. The hybrid teaching or learning can be defined in multiple ways: In one definition the hybrid teaching means that students attend syncronously the same session either physically in a classroom or online [1]; In other definition the hybrid pedagogical method means that face-to-face activities in classroom are combined with technology-mediated activities outside classroom [2, 3]. In this article we use the latter definition. Many times the terms hybrid and blended learning can be used interchangeably [3].

In hybrid teaching some of the seat time in a classroom is replaced with, for example, video lectures [2]. This type of hybrid teaching and learning offers many benefits, such as increased student engagement, increased active learning in class, custom-tailored learning activities for diverse student groups and the possibility to study at a self-paced rate [2]. We believe that hybrid teaching can be designed and implemented using the Flipped Learning Method (FLM).

During year 2020 we have been forced to think our teaching in a totally new way, and we have found that effective remote learning needs new tools and methods. The methods used in traditional face-to-face classroom teaching are not working in remote teaching, we have found them passivating and inefficient for students' learning. One very potential method for efficient hybrid teaching is FLM, and we believe it is going to increase its popularity also after COVID-19. FLM is a learner-centred approach to teaching and studying [4]. The basic idea of it is not new, already dialogues used by Socrates were learner-centred [4]. Research results on FLM to students' academic achievements are varied, some do not show significant improvement, while some do show it [4]. FLM can, for example, help students to learn, increase interactivity in class, and enhance active learning. [5]. Thus, we think that when the FLM is utilized so that it suits well to the course and the subject matter, it will enhance students' learning and helps them to better achieve the learning outcomes.

An academic project has been ongoing for a couple of years for taking FLM into use in the engineering education in Tampere University. The first courses involved in this project were large basic courses in natural sciences. Succeeding those, also other courses have been accepted to the project. The rapid change to remote teaching due to the COVID-19 pandemic on spring 2020 gave us a trigger to apply to this FLM

project with bachelor level electronics courses. Furthermore, the project gave us an extremely good framework to try FLM. The FLM project provides the participating teachers equipment needed in doing short videos, and most importantly, allows the participants to use one month of working time to the course design with FLM.

The change to FLM is not as huge as it might be in our courses. We have already been using blended learning in many ways on our courses, including various activating learning events and assignments, and we have utilized various evaluation models, such as continuous assessment. With the adoption of FLM we are aiming to students' deeper understanding of the important concepts, better skills in problem solving and critical thinking, and better achievement of the learning outcomes.

2 THE FLIPPED LEARNING METHOD

FLM combines face-to-face and online sessions with different kinds of online tasks. The traditional teacher-centred, time, place and pace dependent, information transfer lecturing is moved online, very often in the form of pre-recorded videos or texts. The teaching strategy is moving towards learner-centred [4]. The face-to-face time with teacher is reserved for deepening the understanding of the subject matter, for example, by discussions with the teacher or doing problem-solving activities. FLM is very popular today, and it is increasing its popularity continuously. [6] As FLM requires students to take more responsibility of their learning, they must adopt active learning strategies instead of passive learning [4].

The basic idea in FLM can be found in Bloom's taxonomy, where the complexity of the subject matter increases from lower to higher levels [4]. The face-to-face time is reserved for higher levels in Bloom's taxonomy in FLM, on the contrary to traditional teaching, where it is consumed in the lower levels. This can be seen in *Fig.1*. The subject matter on the middle levels in Bloom's taxonomy can be dealt with both ways, in face-to-face sessions, or self-studying, depending on the case in hand. The students study the basics of the subject matter themselves in FLM, either alone or in groups, by reading, watching videos, or doing different kinds of assignments. The students' conception of the subject matter is deepened in classroom sessions and discussions with the teacher. The focus of the classroom sessions is to engage the students in higher-level thinking and application of the concepts in groups with teacher's support to promote deep and significant learning [7]. The Bloom's taxonomy helps teacher to design the course implementation properly while it aids in the classification of knowledge on the course [4]. It has been found that FLM has positive effect on the students' learning especially in higher levels of Bloom's taxonomy [4]. One big advantage of FLM is that students can utilize the learning methods and strategies that suit them best [6]. Another great advantage is that they can study the self-study parts independent of time, place, and pace.

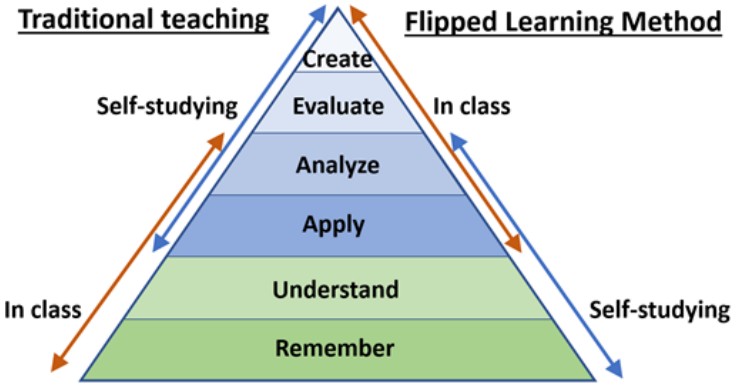

Fig. 1. Bloom's taxonomy with traditional teaching and FLM

3 PLANNING OUR COURSES ACCORDING TO THE FLM

The courses we are designing now according to FLM are implemented on autumn 2021. Some details of the two courses, which are now under design process, are presented in *Table 1*. The first course is a totally new course, that course has not existed before, and the second course is an old course which is now adopting FLM.

Table 1. The courses under FLM design work

Course	Target group	Estimated number of students	New course/ Old course	Duration
Electronics and Circuit Theory	BSc second year	25	New course	7 weeks
Product Design of Electronic Device	BSc third year	30	Old course	7 weeks

3.1 The basic idea and weekly schedule

The planned basic idea in both the courses is presented in *Fig. 2*. The courses last for one study period, i.e. 7 weeks. The course content is equally divided to the weeks keeping the workload constant throughout the course. Every week has basically the same structure consisting of pretasks, online assignments, face-to-face session, online activities, and small group meetings with teacher, as seen in *Fig. 2*. The basic structure can be modified according to the subject and recourses available, but so far, the idea is to follow this basic idea. The designing of the basic weekly schedule needs to be done carefully to accomplish the appointed learning outcomes, to keep the workload constant and to offer students meaningful and versatile learning opportunities.

The starting point of the design is a thorough definition of the learning outcomes and the core contents of the course. Learning outcomes are designed with the help of the Bloom's taxonomy. The core contents and their corresponding learning outcomes can then be divided into different flipping modules with the total duration of seven

weeks. Based on the Bloom's taxonomy level of the learning outcome, it can be designed, whether this learning outcome will be accomplished via pretasks and online assessments, or via the face-to-face sessions.

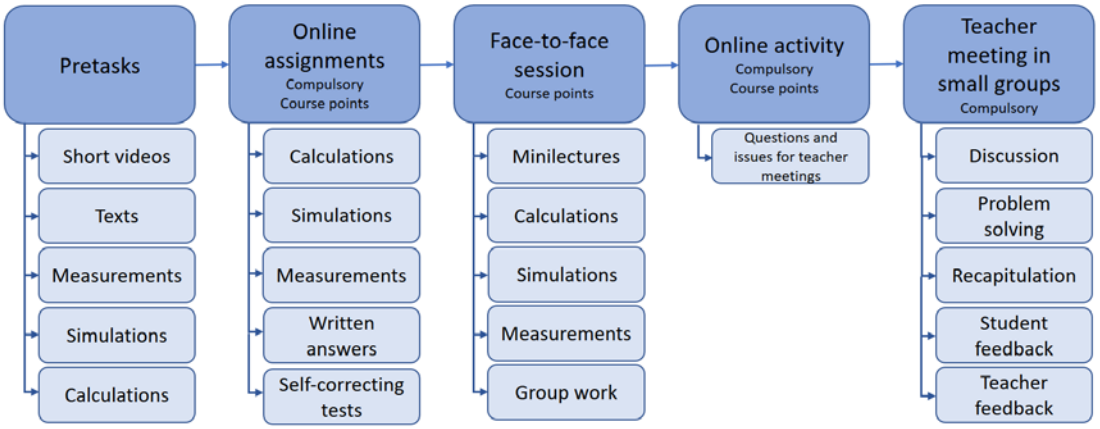

Fig. 2. The basic weekly schedule

The pretasks can be almost anything that helps students' learning on the topic. Potential choices for pretasks in our electronics courses are presented In *Fig. 2*. The student must have acquired the contents and concepts of the pretasks to accomplish online assignments. The main learning outcomes of the self-studying part can be e.g., that the student can describe, define, explain and classify the basic concepts of the subject at hand or to solve and simulate basic problems. Online assignment possibilities that suit well to our courses are presented in *Fig. 2*. In face-to-face sessions for example minilectures can be combined with different kinds of tasks that promote active learning. Examples of suitable task types can be seen in *Fig. 2*. The main emphasis in the face-to-face sessions is to deepen students' understanding of the subject matter. The learning outcomes of the face-to-face sessions can be e.g., that the student can compare, summarize, select, construct, measure and design concepts of the subject at hand. An important aspect of the face-to-face session is also to build a sense of community in learning. This can be accomplished by doing various group work assignments, or by doing measurements and problem solving in groups. Furthermore, in the face-to-face sessions important working life skills, such as teamwork, problem solving, creativity and critical thinking, can be enhanced. Online activity after the face-to-face session is mainly targeted to finding out issues that are the most difficult for each student, then they can be the baseline for teacher meetings. This way each student profits from the teacher meetings the most. Teacher meetings can handle issues in many ways, some suitable ways are presented in *Fig. 2*. The teacher meetings are very good situations for feedback both ways, from teacher to student and vice versa. Feedback for the students during the course helps them to capture their strengths and development areas, and feedback for the teacher helps the teacher in adjusting the course and its implementation to best enhance students' learning.

We provide the students with a bring-your-own-device (BYOD) in electronics courses in Tampere University. The BYOD contains, for example, a multimeter, an oscilloscope, a function generator and a power supply. Tampere University has a software licence required for the BYOD and students can download it to their own computers. This way every electronics student can do basic electronics measurements, simulations, and circuit construction outside campus. Thus, we can utilize the BYOD device when designing the tasks for our courses. This is a great advantage in a subject like electronics, in which different kinds of hands-on skills are essential.

3.2 The basic idea of course evaluation

Both the courses will have an evaluation system where the final course grade consists of multiple tasks done during the course, and perhaps also an exam. The exam can be a conventional exam done with pen and paper, an electronic exam, or both. The planning of the courses is still ongoing, and the final evaluation system is still not yet determined. Regardless of the possible end exam the students will collect course points during the course from different tasks. The planned arrangement for course points can be seen in the weekly schedule in *Fig. 2*. The course points will have a significant role in the final course grade. This encourages the students to work continuously throughout the course aiding their learning. The learning outcomes are important to define so that they are measurable. The course evaluation will be anchored to the learning outcomes so that it will advance learning.

3.3 Experiences on course planning using FLM

Even though the planning process for our courses utilizing FLM is still ongoing we have already noticed some important aspects. Perhaps the first to pay attention to is that the course planning, design and preparation tasks take really a lot of time, a significant amount of time must be reserved for these. This doesn't depend on whether the course is new or old, the time consumption is huge.

Furthermore, what and how much should be flipped needs to be carefully designed. Core content analysis and the learning outcomes play an important role in designing the course. The course design and especially task and video preparations are very time consuming. The short videos, for example, need to be carefully written and often they need to be subtitled also. At the beginning the video recordings might have to be done several times as well. In addition to making videos, different kinds of online tasks must be created. Depending on the learning management system (LMS) in use, for example, Moodle, whether automatic checking is used, and how it is used, the online task planning and making can be extremely time consuming.

Additionally, FLM requires new teaching equipment that must be taken into use. This takes time and creates costs. Videos of good enough quality and flowing learning sessions need something more than just a normal laptop and headset. Fortunately, the FLM project in Tampere University provides us new laptops with very good quality touch and drawing screen, and special microphones for video making.

Support from the institute, the possibility to ask guidance from experts, and peer support can help the teacher in utilizing the FLM. Furthermore, most of the work has to be done for the first implementation of a course, and only once. In the following years the teacher's workload will be significantly smaller.

3.4 Continuous course development

We are right now in the middle of the planning process, and only after the first implementation rounds on Autumn 2021 we know more: What were the things that worked well, what needs further development, how was the student motivation and engagement, and most importantly, how did the students reach the learning outcomes.

Feedback, both the student and colleague feedback, is an important tool to develop courses continuously. We are systematically collecting feedback from students in all our courses, and we use feedback to further develop all courses and study modules. Next Autumn we will design the feedback surveys so that we can find out relevant information of the FLM implementations from student perspective. In addition, we have an intense teacher community where we can discuss teachers' views on teaching related issues, and learn from each other. Furthermore, the LMS provides us useful information especially on the online tasks: We can have reports of, for example, how many times and how long the videos have been watched, and how long and how many attemps an online task required from students. Hence, even though the main planning of these courses utilizing FLM is now ongoing, the development work of these courses is continuous.

4 SUMMARY

The COVID-19 has done a favour to higher education, as well as to other education levels, by forcing the institutes to think about teaching and learning in totally new ways. Even though the change from face-to-face to online studying was done literally in one night on spring 2020, during the year 2020 we really had to rethink teaching and learning over again to increase students' learning and their engagement to their studies. This COVID-19 pandemic, and the support project from our university, triggered us to take FLM into use on our courses on autumn 2021.

Although the planning, design and preparation of courses utilizing FLM take really a lot of time, we believe it is worth it. We are expecting increased students' learning especially on the higher levels of Bloom's taxonomy. Furthermore, the partial independency of time, place and pace offers students possibilities to do their tasks with learning methods, time, place, and pace that suit each student the best. The social aspects of face-to-face sessions are extremely important, and the FLM also takes that into consideration.

We have found that the amount of work for a teacher is huge when taking FLM into use for the first time in a course. However, on the succeeding course implementations the teacher's workload will be stabilized to some much lower level. We assume that the workload after the first implementation will be about the same

as in the case of a traditional course implementation. Hence, the benefit of the FLM is definitively not the saved teachers' work time but the students' enhanced learning results.

As a conclusion, we believe that FLM is a very good possibility for the higher education after the COVID-19. We think that the hybrid or blended teaching methods will be significantly utilized in future and FLM is a very potential method among those. However, the support from the higher education institute is essential in taking FLM into use. Efficient FLM needs special equipment, possibly some new software, resources for the planning work, peer support and guidance in the method itself. As a result, we can assume better student engagement, enhanced learning and learning skills, as well as more self-regulated and active students.

REFERENCES

[1] Gleason B. and Greenhow C. (2017), Hybrid learning in higher education: The potential of teaching and learning with robot-mediated communication, *Online Learning*, Vol. 21, No. 4, pp. 159-176.

[2] Linder K. E. (2017), Fundamentals of Hybrid Teaching and Learning, *New Directions for Teaching and Learning*, No. 149, pp. 11-18.

[3] Hrastinski S. (2019), What Do We Mean by Blended Learning?, *TechTrends,* Vol. 63, pp. 564–569.

[4] Almasseri M. and AlHojailan M. I. (2019), How flipped learning based on the cognitive theory of multimedia learning affects students' academic achievements, *Journal of Computer Assisted Learning*, Vol. 35, No. 6, pp. 769-781.

[5] Roach T. (2014), Student Perceptions Toward Flipped Learning: New Methods to Increase Interaction and Active Learning in Economics, *Internation Review of Economics Education*, Vol.17, p.74-84.

[6] Eppard J. and Rochdi A.(2017), A Framework for Flipped Learning, Proc. 13th International Conference on Mobile Learning, ADIS, Budapest, Hungary, pp. 33-40.

[7] Saichaie K. (2020), Blended, Flipped, and Hybrid Learning: Definitions, Developments, and Directions, *New Directions for Teaching and Learning*, Vol. 2020, Issue 164, pp. 95-104.