Flipping a PhD course using movies from a MOOC

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***Abstract*—In this article, we present the results from an attempt to utilize parts of a MOOC in a PhD course employing a Flipped Classroom approach to teaching and learning. Based on the student feedback and teacher experiences, we examine, how students perceived the combination of videos from a MOOC and active learning activities in the classroom. We discuss advantages and disadvantages that we observed with using videos that we have not recorded ourselves and assess which type of active learning was perceived as most useful by our students. The results show that the waste majority of students experienced the videos and learning activities as very useful for their learning. The group discussions in the practice sessions were most appreciated. The MOOC videos enabled students to engage with the video content at their own pace, even though they were partly perceived as to broad and unspecific. In sum, teachers and students experienced the course as highly rewarding, but also time consuming.**

***Index Terms*— flipped classroom teaching, MOOC, video lectures, active learning, peer instruction, collaborative problem solving.**

I. Introduction

THE past years we have seen a surge of interest in the flipped classroom teaching strategy at many universities around the world [1], [2]. The basic idea is to encourage students to watch a set of video lectures before each class. Given that students become acquainted with the material at home, we free up time with a teacher and peers in the classroom that can be dedicated to active learning [3] instead of lectures. In practice, active learning often involves group activities such as discussions or collaborative problem solving and there is substantial evidence that active learning leads to better learning [4].

One reason why flipped classroom teaching has become so popular now is that teachers do not need much equipment in order to record their own movies and share them with the students. At the same time, many teachers are reluctant to flip their classes because it is considered to be too time consuming to record their own movies [5]. As a consequence, many teachers continue to deliver lectures even though they would have preferred to use active learning. An interesting alternative, which can enable many more teachers to flip their classes, is to make use of videos that someone else has recorded.

In this paper, we describe how we have made use of the videos from a massive open online course (MOOC) [6] to flip an on-campus PhD course in probabilistic graphical models at Chalmers University of Technology. We elaborate particularly on the design of the active learning elements in the classroom. In the course evaluation, we address the following three questions:

1. How do students perceive the combination of videos from a MOOC and active learning in the classroom (the flipped classroom model)?
2. What pros and cons have we observed with videos that we have not recorded ourselves?
3. Which type of active learning is most useful for our students?

Finally, we discuss how the lessons we have learned can be used to improve this and other courses in the future.

II. Course details and design

We used flipped classroom teaching in a PhD course named *Probabilistic graphical models,* when it was given for the first during the spring of 2015. The course is designed around a massive open online course (MOOC) with the same name given by Prof. Daphne Koller from Stanford at the Coursera platform [7].

The course runs for eight weeks comprising 12 two-hour classes (these correspond to 12 lectures). Every week (for the first six weeks) we start up a new learning cycle that lasts for two weeks and that contains several different components, see Fig. 1.

In this section, we provide a detailed description of how we use Prof. Koller's videos to prepare the student before class and how we design the active sessions in class (the upper half of Fig 1.) In addition, for every pair of active sessions, we hand out a set of home assignments (HAs) that students should solve in pairs. The solutions are evaluated via peer-assessment, where each group grades the solutions of another group. The home assignment (and the learning cycle) is concluded with a 45- minute group discussion in class.

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To pass the course, students have to perform the above tasks on a weekly basis and attend at least 80% of the class sessions. Finally, every student is expected to present a research paper at the end of the course. The only possible grades are pass or fail.

During the spring 2015, the course had two teachers and 18 participants in total, among which three students were Master students and the other 15 were PhD students. The students generally had a sufficiently strong background to follow the course.

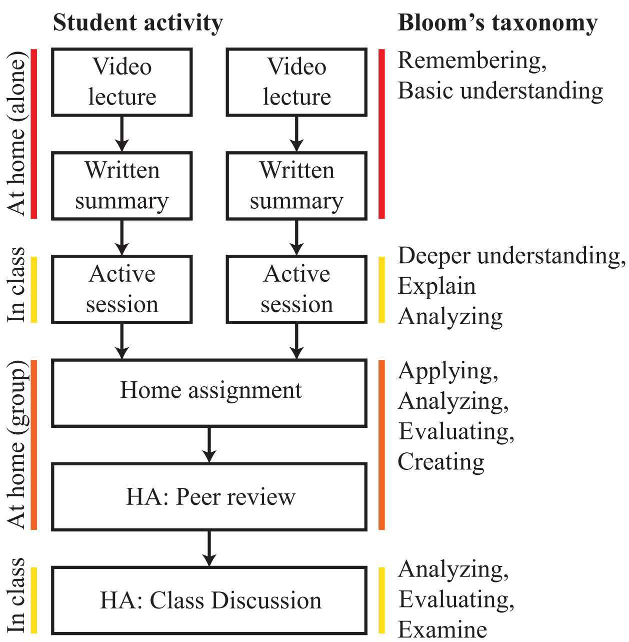

Fig. 1. Bi-weekly learning cycle together with learning activities from Bloom's taxonomy.

A. *Preparing students for class*

Before each active learning sessions, we require the students to watch a specific set of related video lectures from Prof. Koller's MOOC. To ensure that most students watch the videos before class, it is useful to provide students with a strong incentive [8]. In this course, we require them to write a short summary of the material covered in the videos. Students are also encouraged to list things that they found difficult such that we can use this input when we design the active learning sessions [9].

B. *Active Learning in class*

The main objective of these sessions is to engage students in activities that promote analysis, synthesis, and evaluation of the important concepts in the video lectures. During these sessions students are divided into groups of four-five students, whereby it is important to create a good mix of students in the groups, both in terms of background and strength. We use three tools to activate the students: *retrieval*, *peer-instruction* and *collaborative problem solving*. More details about these are given below.

Retrieval as a warm-up exercise

At the start of each session, we ask the students to spend two minutes, in silence, to retrieve and reflect over the content of the video lectures without referring to their written summaries. After reflecting on their own, the students take turns to summarize the material to each other in the group. At the end, they are encouraged to look at their summaries to check if they have missed any important parts. The objective and motivation for this exercise is threefold. First, it gives students an opportunity to explain the material to their peers [10] and to ask about confusing aspects. Second, studies show that retrieval (recalling information) makes it easier to recall the information again and enables longer retention [11], [12]. Third, it serves as an effective tool to engage the students and to initiate thinking processes around the material.

Peer instruction

Peer instruction (PI) is one of the most popular tools for active learning and is used successfully in different learning settings around the world [8]. The idea is to give the students a multiple-choice question designed to illustrate an important concept in the material. After giving the students one or two minutes to think in silence, students are asked to provide individual answers; their answers are tallied via clickers, mentometers or, as in our case, simple colored post-id notes. Unless almost all students answered correctly, the students are asked to discuss the question in their groups for roughly two to five minutes. After the discussion, students again give individual answers. The entire procedure may be repeated several times before the correct answer is announced and explained by either a student or a teacher.

Collaborative problem solving

Another important tool to activate students is to have the students solve problems collaboratively in their groups. We typically use this form when the targeted learning outcome benefits from having the students visualizing something, explaining something in words or walking through the steps of an algorithm. As with the PI problems (but in contrast to conventional tutorial sessions) our objective is to help the students to develop a deep understanding of the fundamental concept rather than practicing advanced calculations or derivations. The problems are also typically more extensive than the PIs and we try to design them such that the students actually need to collaborate in order to solve the problem in the given time frame.

To ensure that students collaborate, we ask each group to produce one solution that they all agree upon and that the other groups can look at. To further help the students to work constructively together within their groups we assign different roles to the group members, which are then rotated after each session. As suggested in [13], we assign the following roles: the coordinator, the reporter, the checker and the skeptic. Among these, the reporter tends to get the most attention since he/she is expected to summarize the solution that the group has agreed upon for the rest of the class (though often with assistance from the rest of the group).

Meanwhile, the teachers actively monitor the discussions and coach the students by asking questions (to help them explore the problem) and give concrete tips when necessary.

III. Course Evaluation

In this section, we present the student feedback. After the course, the students were asked to respond to a course survey about the course and its format. All but one student responded to the survey. The survey contained a combination of multiple-choice questions and free text questions.

Among the multiple-choice questions, some were specifically designed to highlight aspects related to flipped classroom teaching:

1. The lectures in this class were flipped. Claim: this lead to improved learning and understanding.
2. I would rather watch a video lecture with quizzes than a live lecture.
3. The practice sessions where we focused on our conceptual understanding of the material were useful.

The result of these questions is summarized in Table 1. Most of the students found flipped classroom teaching better than traditional lectures even though one student disagreed and (the same student) also had a strong preference towards live lectures instead of videos. The evaluation of the practice sessions was even more positive and it is interesting to see that the practice sessions are so much better received than the video lectures. In a similar study [14], where we had recorded the videos ourselves, 95.6% of the students either agreed or strongly agreed that they preferred videos instead of live lectures.

TABLE I
A summary of results from multi-choice questions on flipped classroom teaching.

	Question 1	Question 2	Question 3
Strongly agree	6 (35%)	5 (29%)	10 (58%)
Agree	8 (47%)	6 (35%)	6 (35%)
Neither agree nor disagree	2 (11%)	2 (11%)	1 (5%)
Disagree	1 (5%)	3 (17%)	0
Strongly disagree	0	1 (5%)	0

The positive student feedback was also reflected in the qualitative comments. The *practice sessions* were perceived as very good as they encouraged students to be more active in their reflections and helped them to understand material that was unclear from the videos. Many students also appreciated the fact that they came well prepared to the active sessions. Most students liked the use of *MOOC videos* because of the free choice when to watch and the ability to adapt the learning to their own pace. However, the videos were also criticized, mainly for two reasons: the missing opportunity to immediately ask clarifying questions and that their content was perceived as too general and lacking depth by several students. A number of students also disliked the *mandatory summaries* and – related to that – the comparatively large course load. On a general level, students still had a positive experience of the *flipped classroom model* and felt that it was preferable to traditional teaching.

IV. Lessons Learned

We conclude this article by summarizing the most important lessons learned, from a teacher's perspective, which may also be relevant for others and in other contexts:

Integrating other's MOOCs is worthwhile

Using other's MOOCs for own courses saves a lot of time that can be invested in facilitating the other learning activities. There are also some drawbacks that should be mentioned, such as the missing possibility to update those videos and that with current platforms, we are unable to see if our students have watched the videos. The first challenge can potentially be compensated through self-recorded additional videos. Our solution to the second problem was to ask students to write summaries, which was not perceived well by all students due to the additional workload. One alternative that we consider is pre-class quizzes, strongly promoted in [8].

Flexible course design with MOOC videos

Even though the MOOC course has certain content, we did not feel limited to that content. To fit our learning objectives we simply skipped videos that we either found less interesting or that covered content explained in other courses. We also added new content by providing articles that the students should read. Furthermore, although the movies are very well produced, it was also clear that they were not designed specifically for our audience (PhD students in the field). Consequently, the movies were not always sufficiently complete in order to meet our learning objectives. When that happened we typically included a short presentation in the classroom sessions in order to provide additional details.

Collaborative learning works in balanced groups

The students generally appeared to be highly inspired and work in a passionate manner on the tasks that they were given. They also generally collaborated in an excellent manner and the discussions among the students seemed to yield many useful insights.

From the start of the course we made an effort to divide the students such that each group had a mix of students with different background. Halfway through the course we made adjustments to the groups to obtain a better mix of stronger and weaker students in the groups. We felt that this improved the group dynamics and reduced the differences in time that the groups needed to solve the problems.

Group discussions need guidance - sometimes

It is important to be prepared to present the correct solution and a clear explanation of what is going on. Without guidance, students sometimes get stuck in misconceptions or discussions that do not take them forward in their learning. After recognizing this problem, we started preparing short presentations on topics that we thought students might struggle with, such that we were well prepared to clarify the solutions whenever the students did not manage to reach satisfying conclusions themselves. Our impression was that these presentation lead to a substantial improvement.

Effective peer-instruction requires good questions

It is important to choose and design PI questions such that they are sufficiently challenging without being too difficult. The aim should be to design a problem that most students can understand during the discussion with their peers (and preferably one that may yield an aha moment). However, choosing and designing a PI problem that has the right level of difficulty is non-trivial. A good guide is to have a clear aim for the intended insight and the connection to the learning objectives for the corresponding lecture. If the intended insight is of a conceptual nature and can be arrived at through (logical) reasoning using what is taught in the course, designing a PI could be a good idea.

Collaborative problems

As with peer instructions, designing good collaborative problems is hard and part of the challenge is again to find the right level of difficulty. If the problem is too easy the students tend to try to solve it individually with little interaction with the rest of the group. On the other hand, if the problem is too hard the students get stressed or disengaged. We found that it helped to divide the problem into smaller parts and to gradually increase the difficulty to help weaker students get started and contribute to the solution.

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