Just-in-time Learning: Can Online Courses Significantly Support Face to Face Teaching?

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Abstract— The University of Applied Sciences (UAS) Technikum Wien is the largest purely technical University of Applied Sciences in Austria. Around 3,300 students are enrolled in 17 bachelor and 12 master degree programs. 1,650 different courses are offered; only about half of them are traditional courses, organized predominantly as face to face teaching. Presently, courses in computer science degree programs designed for face to face teaching are being converted to online courses. One important goal is to add more flexibility to the way students study. Courses offered as online courses allow students flexible ways of learning; they may be able to choose between online and face to face teaching on a level of single teaching units. In some cases, online learning courses and face to face courses in different study programs have similar study content and are thus comparable. The authors previously made distance learning material available in full time (presence) courses of introduction to programming. The evaluations have shown that about 60% used the distance learning videos in addition to the presence lectures [1]. Of those 60% all videos were viewed after the presence lecture, but never before a lecture. In the distance learning course all students used the videos in addition to a book which is used in the lecture and covers the entire course content. Most of the students stated the videos are very useful to repeat what they previously heard in a face to face lesson. Recently, the full-time master’s degree program Software Engineering has been redesigned to become a part-time degree program in order to meet the requirements of current economic trends. This paper summarizes latest evaluations of three newly created courses partly held in distance learning.

Index Terms— Flexibility, Online Teaching, Face-to-face Teaching.

I. INTRODUCTION

With around 6,800 graduates and about 3,300 enrolled students, the University of Applied Sciences (UAS) Technikum Wien is the largest purely technical University of Applied Sciences in Austria [2]. The UAS Technikum Wien offers 4 part-time bachelor’s degree programs and 13 part-time master’s degree programs, allowing students to work full-time while completing their studies and to directly apply learned state-of-the-art methods of science in practice. In many cases project based learning is used to support face to face teaching [3-4].

II. STRATEGIC CONSIDERATIONS

The UAS Technikum Wien started with a full-time program in electronics engineering back in 1994. During the following years the development of a legal basis for offering part-time programs at Universities of Applied Sciences became a major task for development teams at UAS and the Austrian legislation too. Since the year 1997 the UAS Study Act gives the possibility to offer full-time and part-time studies at UAS in Austria. For nearly two decades the terms full-time and part-time have been used to characterize study programs on UAS, but might be misleading. Full-time programs mainly consist of face to face teaching, whereas part-time programs use blended learning scenarios. The average age of students enrolled in part time programs decreased over the years. More students applied for part-time programs also if they are not full-time employed, their goal was to gain more flexibility in their time management. The model could be best described as part-time studying and jobbing. All the part-time programs at the UAS Technikum Wien make use of a blended learning approach with about 60% presence phase on campus and 40% distance learning. This approach is supported by learning management systems like Moodle.

In the future, more flexibility for students will be needed. One measure to cope with this fact is a much higher degree of distance learning. The UAS Technikum Wien started the first part-time degree program in Electronics & Business in the year 2008, with an on campus part of less than 10% of the total curriculum, mostly laboratory-work. As a second part-time degree program Business Informatics started in 2009 [5]. Distance learning and teaching turned out to be very demanding tasks; students in the field of technology have to develop a number of practical skills and a theoretical foundation in science without direct face to face interaction with a teacher.

III. SOFTWARE ENGINEERING DEGREE PROGRAM

A. General Structure

The part-time master’s degree program Software Engineering has been redesigned and accredited in the year 2013, transforming the original two-semester full-time degree program into a completely new four-semester part-time degree program with majorly revised content. Outdated courses have been removed, new ones have been created and existing courses have been restructured in order to fit the demanding requirements of a part-time degree program regarding the challenges of distance learning. The following sections introduce distance learning concepts of three courses within the Software Engineering degree program as well as first evaluations and suggestions for possible improvements.

B. Interaction Design Course

Students of the first semester in the master’s degree program Software Engineering are required to complete the mandatory interaction design course, which teaches guidelines of interface and interaction design as well as prototyping in the context of usability engineering. The course is composed of two parts: the project-based
prototyping part and the distance learning part. As we have found in previous investigations, project-based learning increases the motivation to learn [6].

After an initial kick-off lecture introducing the organization of the course and the technique of prototyping, students are asked to choose a topic for their prototyping projects. One of four supervisors, which are all lecturers at the UAS, is assigned to each group depending on the topic. As soon as the assignments of supervisors are published, the students are required to contact their supervisor for a first meeting, where the individual approach for their prototyping project is fixed. According to the distinct need for support of the group, 2-4 face to face meetings are scheduled, where the current status and necessary adjustments to the project plan are discussed. All groups need to present their results and demonstrate their prototype in front of their colleagues and all supervisors in a common face to face lecture at the end of the semester. The applied concepts of interface and interaction design are discussed in active group discussions, which contribute to the overall learning effect.

The distance learning part starts right after the kick-off lecture and is based on regular distance learning lessons. Distance learning material is made available once every two weeks and includes supportive content for their prototyping projects. Students can regularly check their learning progress using self-assessment questions published by the supervisors. Finally, they can prove their knowledge about interface and interaction design in a final exam on the distance learning material at the end of the semester.

In order to analyze the effect of the created online course on students’ learning outcome, we first examined how many of the students have done the self-assessment questions in the first place by evaluating the activity logs of the online course. The mean completion rates of these five distance learning tasks are presented in Fig. 1. The error bars represent the 95% confidence intervals calculated using the Adjusted Wald method for proportions. It can be seen that the first set of self-assessment questions has been done by nearly all of the students. However, participation decreased as the semester advanced. On average the students did about 50% of the distance learning tasks with a 95% confidence interval from 33% to 65%, indicating potential for improvement in order to encourage students.

In a second step, we analyzed the correlation between the score on the final exam and the number of distance learning tasks completed at least once, the total number of accesses to the distance learning tasks and the overall activity in the online course, respectively. The correlation between the test score and the number of distance learning tasks completed at least once has been found to be weak ($r=0.127$), while the total number of accesses and the overall activity revealed a slightly higher correlation ($r=0.233$ and $r=0.220$, respectively). However, the correlation is still too weak to speak of a significant connection; running a t-test on the measured coefficient returns $p=0.149$, suggesting that this correlation could have been measured by chance.

Fig. 2 shows the evaluation of the quantitatively collected feedback on the interaction design course. After the final exam, students were asked to rate their level of agreement on different statements about different aspects of the course using a four-point scale with 0 being “strongly disagree” and 3 being “strongly agree”. All 33 students of the course submitted a feedback form sharing their opinion. The 95% confidence intervals were calculated using the t-distribution. It can be seen that most of the aspects can be safely assumed to be on the positive side (greater than 1.5). However, some aspects should be considered and worked on for the following year in order to achieve even better results. Making the course more interesting for the students is going to be the first priority as we cannot be 95% sure that students rather agree with the respective statement. Although we focus on teaching how to apply methods in practice as a University of Applied Sciences, students seem to need more guidance regarding the practical relevance of the taught methods.

Verbatim comments students provided suggest that a few more face to face lectures could improve student engagement. We are aware that a trade-off between face to face and distance learning lessons has to be found; the next described course User Experience Evaluation already relied on more face to face lessons and a stricter schedule. Some students also stated that the self-assessment questions did not motivate them enough to continuously do the provided distance learning tasks. Therefore, we are going to revise the distance learning concept in order to suitably motive students. Regular graded quizzes, more lectures in attendance as well as additional exercises are options that are currently being considered.

C. User Experience Evaluation Course

The second semester of the part-time master’s degree program Software Engineering includes the user experience evaluation course, which takes place in the first half of the semester and has therefore been completed by the end of April. The semesters of the degree program have been divided into two parts as the general feedback on the degree program suggested that students had to deal
with too many courses at the same time.

The user experience evaluation course is held by two of the four supervisors of the interaction design course, which is why the feedback on the interaction design course has been taken into account. The new distance learning concept includes biweekly lectures in attendance, starting again with an initial kick-off lesson in the first week, where students learn about the course structure and participate in an active group discussion around the topic of user experience. A short written reflection on the group discussion after the lecture aims to encourage students to recapitulate the topic, giving students something to take away from the discussion. Each lecture in attendance is followed by a distance learning lesson, which is due until the next lecture in attendance. The exercises, which mainly focus on how to measure the user experience, are graded and the results have to be presented by all groups. Certain aspects of the distance learning tasks are revised using a short quiz at the beginning of a lecture in attendance in order to ensure that all students participated in the distance learning part. Finally, a written exam evaluates the overall learning outcome.

At the time of writing, the course had just been completed. 28 out of 32 students have written a meaningful reflection on the group discussion, showing that they revised the topic and benefited from the discussion. The first and second distance learning tasks had been done by 14 out of 15 groups, indicating that they made themselves familiar with the provided topics, while the third distance learning task had been done by 26 of 32 participants and the quiz on the distance learning tasks was done by all of the students.

As the distance learning tasks of this course were graded, we could evaluate the correlation between the scores on the distance learning exercises and the final exam in order to examine whether participation in the distance learning tasks generally contributed to a better learning outcome. Fig. 3 shows the results of 30 students, revealing an interesting pattern following an apparent trend (two students have been excluded from the analysis as they were absent on the day of the exam). The correlation of these two variables has been found to be strong ($r=0.700$), suggesting that students who did well on the distance learning tasks will also achieve higher test scores in general. Running a $t$-test on the correlation coefficient returns $p=1.68\times10^{-5}$, indicating that there actually is a significant dependency. If we only consider the scores on the quiz on the distance learning tasks, there already seems to be a connection to the exam scores ($r=0.617$), which is also significant ($p=2.82\times10^{-4}$). Therefore, we think that this revised distance learning concept is more suitable for part-time master’s degree programs; the biweekly graded distance learning tasks with portioned distance learning material seem to prepare students more appropriately for the exam than open ungraded self-assessment questions. While the students are able to choose the time and place in a flexible way to do the exercises, there are still some constraints to keep in mind in order to motivate students and prevent them from doing everything at the last moment. Thus, we will focus on refining this proven concept and introduce it to other courses held in distance learning.

D. Parallel Programming Course

The course parallel programming also takes place in the first half of the second semester and aims to introduce concepts of parallel programming. The teaching language is C using the OpenMP-API. Since the course is offered to master students, the attendees are already skilled programmers and usually even have knowledge of multithreading. Therefore, the students have more freedom in their choice of their programming language and also in the choice of their project, provided it offers constructs that allow efficient parallel programming.

In the course itself, we use the principle of blended learning. The students should work two ECTS at home while two ECTS are held in the university. The lectures are offered as videos for the students to consume at home. In the university, the students can work autonomously or under supervision on exercises and projects.

In the distance learning phase of the course, the students should consume video lectures. These video lectures present slides and also show some “live programming” of parallel programs so that the students can implement the program while listening to the lecture. This way, they can focus on the important parts of the source code.

For every topic that is discussed in these video lectures, there are multiple background questions that should motivate students to think. In order to control the learning process, every topic closes with a quiz in which within very little amount of time some questions have to be answered that are easy to solve for everyone who paid attention to the video lecture. These quizzes are not mandatory, but they contribute a small amount to the final grade in order to motivate the students to solve them.

The video lectures are partitioned into sections and topics where each section consists of one or more topics. At the end of each section the students have to solve an exercise - usually implement a program that is slightly more complex but still similar to the programs that were implemented in the video lectures.

These exercises can be implemented in any programming language the students prefer, provided that they apply parallel APIs. This level of flexibility is in the major interest of students since most of them have already acquired extensive knowledge in some programming language like Java or C#, hence they more benefit from deepening their knowledge in their preferred programming language, and they do not consume too much time learning the basics of another programming language. In particular, Java8 and C# offer new mechanisms for parallelization and therefore this freedom of choice is a major benefit for students who are mainly using one of these programming languages.
Still, the teaching language is C and OpenMP, and the mechanisms for any other programming language have to be obtained by the students themselves. This can be done in the presence phase of the lecture. In the class room, the students work themselves on the exercises where we allow to work in groups consisting of at most two people. This phase is supervised by the lecturer. There is enough time to address every student’s individual problems.

In class, the students also work on small projects. In these projects they should find themselves some algorithms or programs and parallelize it. These parallelized programs are presented at the end of the course. In this final presentation, the students focus on the programming patterns they used for parallelization. Therefore, all students get an overview of parallel APIs also in other programming languages.

Although we offer some topics of projects, many students already come up with some topic of interest in which they have already gained some experience. Topics that were picked by students themselves had a wide range and covered Fourier analysis or convex hull algorithms.

The final grade consists of the quizzes, the exercises, the project and also a final test that has to be solved by all students individually.

In general, this teaching construct allows us to offer more flexibility for skilled students without “scaring off” less experienced programmers, and the students respond well to this organization. Fig. 4 shows the percentages of the eight video lectures viewed by the students; the error bars represent the 95% Adjusted Wald confidence intervals. It can be seen that most of the students actually view the distance learning videos before they implement the exercises in attendance. On average, the distance learning videos are viewed by about 70% of the students with a 95% confidence interval from 51% to 82%, indicating that this flexible way of attending distance learning lessons is used and appreciated by the students.

At the time of writing, the exam and exercises have not yet been graded. Further investigations in order to analyze the correlation between viewing distance learning lessons and the learning outcome will be conducted. An especially interesting aspect will be whether those students who do not view the distance learning lessons can achieve the same learning outcome as students who do, which would suggest that they already know most of the taught concepts and do not require these distance learning lessons.

IV. Conclusion

Students in computer science increasingly demand more flexibility in learning. One of the reasons is that many students work part time to earn money and practice their skills at the same time. In many cases, traditionally scheduled face to face teaching does not allow students to work besides their studies. Well-designed online courses allow increased flexibility, address different types of learning, motivate students to deepen their knowledge of a certain topic on their own, create an appropriate social environment, and help students manage their daily tasks more easily.

The distance learning concept of the interaction design course needs to be revised in order to increase the motivation of students to do the distance learning tasks. Ungraded and open self-assessment questions are seemingly an unsuitable method to encourage students. More lectures in attendance, graded quizzes as well as additional exercises are options that are currently being considered.

As current evaluations suggest, the user experience evaluation course seems to use an appropriate distance learning concept which encourages students and benefits the overall learning outcome, despite the fact that the topic of applied statistics always seemed to be hard to teach. Furthermore, the overall participation in the distance learning part was very satisfying; biweekly graded distance learning tasks and portioned distance learning material seem to prepare students appropriately for the exam.

The parallel programming course used a different approach: students were asked to view the distance learning lectures at home and do the exercises in attendance. First analyses have shown that most of the students actually watched the videos. The influence on the learning outcome will be analyzed as soon as the grades are published.

Currently, all online courses are accessible for all students in all semesters, enabling them to get to know topics not covered by their curriculum. The authors also consider making use of entirely taped lectures in addition to face to face lectures, allowing students to revise and look up certain aspects of lessons.

REFERENCES


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