From lectures to interactive blended learning: Two hands-on experiences

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ABSTRACT
This study describes how we changed classical lectures into interactive learning, combining online materials with different physical ways of interacting. The first case is a local course, taught at the Aalborg University campus in Aalborg, whereas the second case regards a course offered between 7 different European universities. Thus, the possibilities for physical interaction are very different. In both cases, the approach was positively received by the students. However, in the first case it turned out that the students were using the material differently than initially designed for: In particular, most students preferred to work on the quizzes in groups (with videos and literature as supporting elements). In this way, the material turned out to be a good facilitator for peer learning, and in our view more "active learning" than initially thought. Experiences from the first case was used to change the design in the second.

Keywords - interactive teaching material, blended learning, online learning material, active learning.

I INTRODUCTION

One of the main challenges the universities are meeting these years is the increasing amount of students with different backgrounds. This is driven by a number of factors, including:
- In general, a larger number of students are pursuing higher education, leading to increasing diversity in student's motivation and learning styles.
- For certain technical fields, such as electrical engineering, there is a high labour market demand for the candidates, while the number of students interested in the field is decreasing. This is leading to a situation where the universities need to contain a wider group of students with different goals and learning styles.
- Increasing mobility among students, where it is becoming more common to take one or more semesters abroad, and/or combine bachelor and master studies in more different ways. Even if efforts are made to ensure all students have prerequisites for all courses, this does lead to a situation where different students have more diverse backgrounds and experiences than before.

These challenges call for teaching methods different from the traditional classroom teaching, but also for methods which allow a more personalised approach in terms of both form and content.

In addition to these general challenges and observations, which are in line with those described in (European Commission, 2011) we identified a potential for improving student's outcomes for a particular course, a 5th semesters course on "Communication in Electronic Systems", which is a mandatory course at the B.Sc. education in Electronics and IT at Aalborg University. Both ongoing discussions with students and exam results revealed a potential for increasing the student's outcome of the teaching, and thus the main motivation was to better help the students to fulfil the learning objectives of the course (and consequently obtain a better knowledge of the topics covered in the course). Increasing the fraction of students that would pass was also a supporting factor, together with increasing the general interest for the topic. With this as a main motivation, we re-developed the part of this course that focused on computer networks.

In this paper we describe how we re-implemented the course based on blended learning, through the creation of video lectures and interactive online material in combination with face2face workshops and seminars. We discuss our observations and experiences with this teaching format. Moreover, we describe how the same methodologies were later applied in an international course, and the experiences collected in this setting.

The paper is organised as follows. Section II presents how the material was implemented in the 5th semester course. Section III the implementation in the international course. Section IV summarizes our experiences, conclusions, and recommendations for future works.

II Case 1: 5th semester course

The idea

The basic idea was to convert each classical lecture (typically 2x45 minutes lecture + 2 hours of problem solving in groups) into an interactive lecture module. For each module, the student was expected to go through the following steps:

- Study the literature specified and watch 1-2 video lectures covering the material.
- Take an interactive quiz generated by us in Moodle. Based on the answers provided, the student receives instant feedback for both correct and incorrect answers, with suggestions as to which literature and videos to study again.
- The student can then study more and re-take the quiz, with no limits as to when and how many times the quiz can be done. The quizzes were designed to cover the learning objectives of each module, so when the student would be able to correctly answer all quizzes he would also be well prepared for the final course exam.
- The students were asked to finish each quiz by a specific date, usually two days before the workshop of each module.
- Based on quiz results (which could be accessed by teachers) and student feedback by email, a face2face workshop was designed inspired by the concept of just-in-time learning (Novak et. al., 1999). The workshop was scheduled for 4 hours and usually started with 30-60 minutes of lecture (a combination of theory and going through examples), followed by problem solving in groups with teacher assistance available. Initially it was concluded by a joint Q&A session, but this was eventually skipped since all questions were answered during the problem solving. Both lecture content and problems were based on student feedback and quiz results.

Implementation issues

It was a clear aim to establish a clear alignment between learning objectives, topics covered, teaching methods, and the final exam. This was done by establishing clear learning objectives for each of the interactive modules, so that the modules all together would meet the learning objectives of the course (which were not changed compared to the previous versions). Based on the learning objectives for each module, the quizzes were created to ensure that the topics were well covered. With quiz and learning objectives for each module in place, the lecture was designed to cover these aspects, and after this ready to be recorded. Also, during this process, the exam questions were defined to ensure that no topics were overlooked in the module quizzes and lectures. The process requires planning well ahead of course start. The students, on the other hand, could also clearly see this – in fact, the learning objectives for each module was explicitly presented in the beginning of the video of each module.

In order to make slides as well as lectures available in a high quality (audio and video), the video lectures were recorded in a dedicated video studio which was kindly made available to us by the University of Stavanger, Norway. The recordings were made in two "tracks", so the lecturer and power point slides are separated in the recordings. This makes it possible for the student to control how to watch the lecturer and the slides at the same time. Another advantage of the professional setting is that slides are numbered, so it is possible to "jump" in the video stream, either from slide to slide, or by looking for a particular slide. A search function can also be made available for the students, but it was not implemented in our setting since it required additional work to indicate key words for each slide.

The quizzes were created in Moodle, which is the teaching platform used at Aalborg University. It turned out to be quite a strong tool, with different ways of asking questions and defining answers, even when immediate feedback is offered to the student. In addition to classical multiple choice, this includes matching questions (matching multiple statements with possible answers), answers in terms of text (asking the student to provide for example a word), and answers in terms of numbers. Asking all questions on this type, without allowing for answers containing text, explanations, drawings, etc. was a challenge, but especially using the ability to check the correctness of numbers made it possible to test all learning objectives in a satisfactory way.

On the positive side, Moodle allows to give different feedback to students depending on which answers they are providing. Not only does it allow for providing different feedback for correct and wrong answers, but answers that indicate e.g. common misunderstandings or misconceptions can initiate particularly helpful feedback. Due to time constraints, in this case the students were just informed if their answer was correct (and otherwise what would be the correct answer), and in case of both wrong and correct answers they were pointed to information sources (e.g.. specific book pages and specific slides) for more information. Initially the idea was to do this only for wrong answers, but there was no reason not to advice students with correct answers, who for some reason did not feel completely comfortable with the question.

It should be noted that the final exam is still "with pen and paper". Despite the questions being formulated in similar ways to what the students meet in the course, they are allowed to elaborate or explain their answers, making it possible to award points to partially correct answers which would be difficult based on the electronic questionnaires.

Experiences during the course

The first observation was that the students expressed a positive attitude to the approach, so the initiative was well received. During the first modules, almost all students came well prepared, had done the quiz, and also had handed in questions/suggestions that could fill out the workshop. The workshop would usually be going through additional examples on the blackboard, followed by additional (and more traditional) problem solving in groups. The students generally expressed a high satisfaction with the course, and the fact that they could study the material in their own pace. Some did realise a main weakness in the videos, namely the lack of possibility to ask questions and get answer on-the-fly, and thus it is possible to get stuck halfway through a lecture. With classical lectures, it is possible to ask such questions during the lecture (even though not everyone is taking advantage of the option).

After the first modules, the attitude slightly changed, and fewer students would show up well prepared. With less topics for the workshops, the students instead spend the workshop timeslot on going through videos and quizzes in groups, with teachers passing around with help and guidance. While different than designed, this appeared to be a quite effective way of learning, and the students became quite active in the process: They would discuss both questions and answers, study additional material, use the blackboard, and explain and discuss concepts among each other. Also, this solved the above mentioned problem of missing the opportunity to ask questions during lectures.

Many students also expressed that they were particularly happy about having the material available for exam (or even re-exam) studies. Making a strict comparison of exam results compared to previous years was not done though. Partly because the exam questions were completely re-formulated and this not comparable, and partly since it is a different year of students, to different results would be expected in any case.

Observations and learning points
The main objective was to better help the students fulfill the learning objectives of the course, and obtain a better knowledge of the topics covered by the course. Based on our observations, discussions with the students, feedback during semester group meetings, and exam results it is our clear impression that this objective was reached. However, we did not conduct a scientific study, and we are aware that student evaluations, feedback and exam results might also reflect that students differ from year to year. In the following year we did similar observations, though, which together with the student feedback supports our conclusion that the teaching methods have improved the learning outcome.

While the feedback was generally positive, a number of observations and learning points were done during both first and subsequent years.

Based on a questionnaire distributed to the students, as well as oral feedback from students during workshops and semester meetings, it was very well received. However, it turned out to be sometimes used slightly different than designed for. This is not a problem, and in fact it worked fine with the students using the material for more collaborative learning during the workshop time. However, making the video lectures shorter would make them even more useful in both self-study and collaborative scenarios, so our recommendation would be to have shorter video clips (5-10 minutes) with quizzes in between each. This would make the learner more active, and consolidate the knowledge before moving on.

We also observed that having material available online is a big help for students in other semesters, who need the knowledge – for example students from abroad who are preparing for a new semester, or students who need the knowledge for e.g. project work. Being able to simply provide them a link and an offer of help can be a big help, without too much effort. In fact, the module has also been used for lifelong learning initiatives, where part time students from industry can refresh their knowledge before attending e.g. master educations.

One challenge is also that it is hard to make slight improvements. Changing or adding material often leads to revision of both slides, videos and quizzes, which is cumbersome, and especially the videos require lot of work in case a new recording is needed. Using shorter videos would help on this issue, especially if video recording equipment could be made available locally.

III Case 2: International course module

The Colibri course
Colibri (Colibri, 2015) is an international project supported by Erasmus+ in the framework of Strategic Partnerships. 7 universities together with 2 companies and a national documentation center, are together developing a course based on blended learning, where students will work together in interdisciplinary and

international teams on solving actual problems from real companies. The overall aim of the project is to test new and innovative teaching methods, with particular focus on internationalisation, personalization, and the use of ICT tools. With a focus on these aspects, the teaching methods to be tested are defined from year to year in the beginning of the cycle as described below.

The Colibri course will run each spring in 2015, 2016 and 2017, each year followed by four students from each of the 7 universities involved. The overall topic of the course is "Future Internet Opportunities", and the students come with different backgrounds within e.g. telecommunications, computer engineering, business informatics, and entrepreneurship. The course accounts for 5 ECTS, corresponding to around 150 hours of work for each student.

Each year, it is organised according to the following plan:
- Around March 1 a virtual kick-off introduces the students to the learning objectives, the course, and the methods used.
- From March 1 and until mid April the students follow course modules each being offered at 2-3 levels (each students select which ones to follow at which levels).
- Mid April a physical seminar (midway seminar) is held, where the course modules are finished, and the project groups and project problems announced.
- From Mid April until Mid July the students are working together virtually on the project, inspired by the Aalborg PBL Model (Kolmos et. al., 2004).
- A final seminar (project seminar) is then held in mid July, allowing the students to finish the project work, prepare project presentations, and eventually attend an exam.

There is no separate exam for the modules, but the students are expected to use relevant material from the modules in the project, and should be able to demonstrate this knowledge during the examination. The examination is based on a presentation of the project (as a group), followed by a discussion session that also includes individual questions.

In this paper, we will describe the design of the course modules, with particular focus on the module on network security for which AAU is responsible.

The idea
In order to be consistent and not confuse the students too much, the teaching material form used in the Colibri modules is defined in the beginning of each round of Colibri. This is done in terms of a number of "teaching tools" that can be used, but it is not required that all modules make use of all the available tools.

Our Colibri module on network security is offered at two levels: Introductory level, to be followed by all students, and basic level, to be followed only by students who selected the topic. Since the student workload of the introductory part is only 1 hour we will focus mainly on the basic part, which account for a student workload of 5 hours.

The form of the module is inspired by our previous experiences from the 5th semester course described in case 1. Thus, the module is composed by the following elements:
- An introductory test, where the student can test if he has the prerequisites to follow the course. If this is not the case, he is suggested material that can help him get to the right level – some of this is provided by us, and some is links to external sources.
- Video lectures with a duration of 5-10 minutes. The introductory part contains 3 such lectures, whereas the basic part contains 4.

- Quizzes in Module for self-assessment. In addition to a quiz after each lecture, there is also a "final" quiz after both introductory and basic parts. This also serves as a midway-exam, since the students are expected to successfully finish this before attending the midway seminar.
- Moreover, some individual assigments are introduced as part of the basic course.
- Given that the students are spread over different physical locations, a Moodle forum is introduced instead of the face2face workshops.
- One hour was set aside during the midway seminar to finish the module, mainly for on-demand topics and questions.
- In addition to finalising each module, a panel discussion was organized with all module responsibles being present in the panel. The purpose was to help the students binding the content of different modules together, and to see how each module would fit into a bigger picture.

Other modules explored also other ways of using peer learning (e.g. with joint exercises in groups that had to collaborate across distance, and/or peer assessment of tasks).

A full overview of Colibri can be found in (Lopez, 2015).

Implementation issues
The implementation was done largely similar to the previous course. Even if there was no specific examination of the module, there were clear learning objectives, and these were translated into learning objectives of each session of video+quiz. The recordings were done in a less professional setting due to time constraints, but again Moodle was used as a platform for quizzes and forum discussions.
As part of Colibri, all teaching materials were made publicly available. For this reason the videos were published on Youtube, and all material (including all slides) had to be done without the use of copyrighted material.

Experiences during the course
The first experience was during the kick-off meeting. We experienced how difficult it is to run a video conference call between participants in 10 different locations, especially when many are not used to multi partner video meetings. This confirmed our initial expectation, that such sessions have to be very carefully thought through.

For us as lecturers, it felt very different to give a course for students you have never met, and without the possibility to physically meet until the end of the course. While it is possible to track the students progress in Moodle, it does not provide the same feeling for how the students are doing and what they need. Based on what we saw in other modules, it is our experience that it was important to define exactly what was expected from the students, something that was supported by the use of Moodle quizzes.

When discussing the teaching material with the students during the midway seminar they also expressed that the form with videos and quizzes worked well, and they recognized that it allows students with different backgrounds to study in different speeds.

During the midway seminar, the panel discussion worked out to be more valuable and lively than the session arranged for each module – for the security module, it was clear that most students had understood the content, something that also showed in the results of the last quiz.

Otherwise the module was well received. Afterwards it was evaluated through a questionnaire filled out by all students with the following results (respondents are those who followed the basic module, in total 17 students). All questions are evaluated on a scale of 1-5 (1: very inefficient, 2: inefficient, 3: neither efficient nor inefficient, 4: efficient, and 5: very efficient)

- With respect to how efficient the overall learning experience was, 12% rated as efficient and 82% as very efficient. One student did not answer.
- The video lectures were rated as efficient by 24% and very efficient by 77%.
- The questions/quiz material was rated as either efficient nor inefficient by 6%, efficient by 18% and very efficient by 71%
- The Q&A forum was rated as inefficient by 6%, neither efficient nor inefficient by 29%, efficient by 18%, very efficient by 12%, and 35% did not reply (or did not use it).

The lower rater for the Q&A forum is not surprising, since it was not very clear how the students were expected to use it, other than asking any questions that could come up during the course. We believe that the scores would have been higher if it was used in a more structured and well defined way, closely linked to the learning objectives, such as how the videos and quizzes were used.

In addition to the evaluation of this specific module, we asked the students how they perceived the teaching methods used in the Colibri course as a whole, compared to traditional teaching methods. These results will be described and analysed in future articles, but includes the following answers (all from a scale 1-5, where 1 is lowest and 5 is highest):
- Compared to your previous university experiences, please assess the following: To what extent do the teaching methods used in Colibri increase the quality of the learning offer? (average 3.7, with 63% of the students answering 4 or 5).
- Compared to your previous university experiences, please assess the: To what extent do the teaching methods used in Colibri increase the relevance of the learning offer? (average 3.7, with 70% of the students answering 4 or 5).
- Compared to your previous university experiences, please assess the following: To what extent do the teaching methods used in Colibri increase the labour market relevance of learning provisions and qualifications? (average 4.0, with 74% of the students answering 4 or 5).

It should be noted that this evaluation covers both course modules and project work, and that the project work was generally very well received by the students.

Observations and learning points
First of all, the material generally worked out well and was well received by the students. The adjustment of the form into the use of smaller videos worked out well.

A learning point is that, especially when there is limited or no possibility for face2face interaction, it is important to be very clear when communicating instructions and expectations to the students. However, even with this made clear, we still were missing feedback from the students. If and how this can be done is a question for further exploration, but maybe a beginning can be a more systematic tracking of progress than what is possible in the current module. Another approach could be to use the forum in a more systematic way, but we are unsure how this can be done in a practical way.

An aspect not related to each single module also became clear during Colibri, since each student had to follow a number of different modules: The need for some level of homogeneity. Even if all modules were based on the same platform, and in principle using the same tools, it could become confusing for the students to follow the different modules in parallel. This does not matter so much when introducing new methods in a single course, and we do not believe that "one size fits all". But at least it is something to keep in mind when implementing new teaching methods on a larger scale.

We would also say that it is important to carefully consider how the very limited face2face time is spent in the best possible way, especially in a setting where neither students nor teachers know each other well. The panel discussions worked out well, and it could be interesting to explore more ways of "active interaction", where the different backgrounds and perspectives of students can actually come into play – and more so than by solving mono disciplinary problems together. We are aware that this of course depends on which learning objectives are formulated.

IV Conclusions

In this paper we have described how classical lectures have been change into interactive modules, based on the combination of online materials with different ways of physical and virtual interaction. In particularly, we have presented two case studies – one from a local course in Aalborg University, and one from an international course shared between 7 different European universities.

The overall idea has been to combine video lectures and online quizzes with immediate response with on-time lectures (in the local case) or a seminar at the end of the module (in the international case). A Q&A forum was also made available in both cases, but not very widely used. Overall, the material has been well received by the students, and it is our observation that it has contributed to increase both learning outcome and student's motivation and interest.

It is our conclusion that for success it is important to have a clear alignment between learning objectives, video material, quizzes, and exam/evaluation. Also, clear instructions on how to use the material is needed especially in the international case where there is no or very little interaction between students and teachers.

Our future work can be divided into three parts.

The international Colibri course will be further developed through 2016 and 2017. For the course module, we would like to explore how we can integrate more interaction between students, and between students and teachers, while maintaining coherence between learning objectives, teaching material, and examination. Also, it is important to keep it very clear for the students what we expect them to do, and when they have fulfilled these expectations. We will also explore further the individualization, and how the pre-test and pre-material can be used. In particular, students who already are partially familiar with the course could be recommended only the parts that they miss. This would be very useful in Colibri, since the participants come with different backgrounds, but also beyond.

For the local course, the plan is to redesign the course, so the current modules are split into sub modules with shorter videos and quizzes, while each module should still have a final quiz. Moreover, we would like to increase the amount of questions in the quiz bank, so students can re-take the quizzes with new questions covering the same learning objectives. As this is quite work intensive, it could be interesting to co-create content with other universities while still maintaining the face2face activities as local activities. As the course is quite a fundamental course, other universities do have courses with similar content and learning objectives.

For the general study, we would like to work more systematically with evaluation of how well new teaching methods work. For this reason, we are currently establishing collaboration between our department and the Aalborg UNESCO Centre for Problem Based Learning (UNESCO, 2015).

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