Abstract

Due to cutbacks in universities budgets and growing numbers of students in the industrialized countries and the emerging economies lecturers often are facing the problem teaching huge numbers of students, which causes a lack of supervision and personal support. This so called educational mass production is lamented by both students and lecturers. This field report gives an overview on the authors experience while developing and testing an E-Prototype of a Distance Learning system that was developed on the basis of the course room and learning content management system Moodle and tested during winter semester 2012/13 at the University of Applied Science Ingolstadt (today Technische Hochschule Ingolstadt). The set up followed the methodology of Inverted Class Room Model and was tested with two student groups (part time students and regular students). In total 440 students, four tutors and four professors were involved in this test case.

Keywords: Innovation; inverted classroom model; distance learning; e-learning; blended learning;

1. Introduction

Disciplines or modules like Applied Computer Science or Mathematics deal less with factual knowledge or methodology but more with imparting ways of thinking. A well-proven way in teaching these topics at universities is providing exercise courses beside the lectures. Students learn new ways of thinking by practicing given exercises tutored by an expert, e.g. lectures or post graduate students etc. Facing the problem, having larger groups of students new methods in teaching have to be implemented to allow students practicing under guidance and in personal contact to a qualified teacher. Beside this the growing percentage of an age cohort starting studies causes the fact the

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average student need more time to understand new ways of thinking or methodologies. In addition the paradigm of life-long-learning leads to a growing number of part time students which are not able to spend more time at university campus. So the main motivation in developing a new course was maximizing the room students have to exercise themselves while having access to a qualified supervisor and give them the highest grade of flexibility in their personal time management.

This paper gives an overview on teaching methodology and the related E-Prototype of a Blended Learning system that was developed on the basis of the course room and learning content management system Moodle and tested during winter semester 2012/13 at the University of Applied Science Ingolstadt (today Technische Hochschule Ingolstadt). Blended learning is a learning method that combines traditional face-to-face classroom methods with computer-mediated activities (e-learning). According to its followers, this method creates a more integrated approach to learning and the proportions can be adjusted to students’ needs as well as to teachers’ preferences. This activity was part of the RiFLE project, more information about this project can be found on the projects web page [1] and the projects’ handbook [5].

2. New ways of teaching

The traditional way of learning and teaching is getting information during a lecture first and doing some practical exercises afterwards. During the lecture questions and answers are hard to manage, so students often do not get a chance to be involved in a discussion. In addition during practical exercise no guidance is available. Taking into account the features of today's information technology this approach does not look efficient anymore. Transporting the knowledge using modern communication channels allows more room for practical exercises under supervision of the lecturers.

Following these preliminary considerations some changes in the structure of current courses are necessary. A promising approach is the so called Inverted Class Room Model where the time slots for knowledge transfer and exercising are inverted. Students get the facts before the lecture starts (e.g. by video or audio files) so the time the lecture is scheduled is available for doing more practise and having contact with the lecturer who is supporting students in doing exercises on their own. The set up discussed in this paper follows this methodology and was tested with two student groups (part time students and regular student). In total 440 students and 4 professors were involved in this test case.

The form of this contact time can be different and in our course we defined two types, the Plenum and the Exercise Course. A Plenum in general takes place in the same lecture room like regular lectures. The term is taken from the old Latin word plenum, which means a convention of peers, where discussion and arguments can take place. An Exercise Course describes a course where student perform practical exercises in small groups or on their own, while a lecturer is present to help them on demand.

The reason for developing a new course was the understanding of the fact that our world and therefore content of learning became more complex because of the growing number of correlations. Therefore today's graduates still need a lot of knowledge but also an overall understanding of their field (domain). Bringing this together with the insight of the thought of Confucius that doing is the best way of learning, the aim of the new course concept is getting more room for practice while keeping a high level of knowledge content.

Fig. 1. (a) Conventional structure of a lecture; (b) Structure of Inverted Class Room Model at a glance

To ensure a proper validation of the developed course a test course was held in winter semester 2012/2013. In order to get representative results and get results from different perspectives the test course had to have a large number of attendees with different backgrounds. Furthermore the course should not be an easy course. For the this reasons the course ‘Ingenieurinformatik’ (computer science in engineering) was chosen. This course is given to regular and part-time students from different programmes. In the contemplated semester there were three regular classes from
mechanical engineering, three regular and one part-time classes from automotive engineering, one class from aerospace engineering and some repeating students from sustainable energy engineering involved in the test course. In total 440 students and 4 professors were involved in this test case. The test includes the perspective of regular students and the perspective of part-time students, which are a growing group especially in today's master programmes.

Since the content of the course is very abstract and since the students in engineering science are mainly interested in more concrete applications, the exam’s fail rate was 45% in the past. This high number illustrates the need for action in this area.

In Fig. 1(a) the conventional structure of a semester week is shown. It contains a preparation phase, where students shall read some books or papers. In practice, most students don’t do this preparation. After the preparation phase the lecture takes place, where conventional lecture means the format where one lecturer is talking about the content and students may ask questions on demand. After the lecture students should do a wrap-up resp. recapitulation to ensure they got all the information. In practice, most students don’t do this recapitulation. Beside this some additional activities, exercises and optional homework may be provided. In most cases the aim of this exercise courses is to allow students getting some practical experience.

The Inverted Class Room Model takes the imparting of knowledge to a phase before the lecture is scheduled (see Fig. 1(a)). Therefore the content is split into several topics (chapters). The content is prepared using different media like Pencast, ScreenCast, Script etc. and can be provided using internet. Topics are assigned to the weeks in semester. Splitting the content into topics and not in different weeks allows the students a flexible access to explanation of different facts and allows reusing the content in a reassembled way for other courses and for different length of semesters. Each week a Plenum and an Exercise Course according to the weeks' topics is provided.

Plenum in general takes place in the same lecture room like regular lectures. In our adoption of a Plenum the content is given by a sample exercise described in the preparation. The lecturer is acting as a host and delivers a short introduction to this exercise at the beginning. After that the lecturer's role is to mentor students who deliver a presentation about his/her solution while being supported by other students. This leads to a discussion about advantages and disadvantages of different solutions. As outcome students get an idea that there are often different solutions to the same problem and that engineering means finding the solution that fits best and is well supported by an argument.

Exercise Course describes a course where students perform practical exercises in small groups or on their own, while a lecturer is present to help on demand. As seen in Fig. 2(a), this means that while students work on their individual exercises or in small groups, the lecturer walks around, gives hints and answers questions. In our case this Exercise Courses takes place in the computer lab where students can use the personal computers provided by the Faculty M / I2CM-Lab and solve the exercises given in the preparation phase. To ensure students use the whole semester to work (and not only some weeks before exams) we combined this exercise course with some homework. This means the solutions of exercises has to be submitted via the online platform as prerequisites for admission to examination.

Fig. 2. (a) Exercise Course - Lecturer as a coach; (b) Different kind of interaction in Exercise Course and Plenum

In contrast to the conventional model the role of a lecturer became more complex. The lecturer gets more intensive contact with students; he needs to be very familiar with the content of the course and its practical application, because questions of students during doing practical exercises are more about concrete facts. Moreover, the lecturer is no longer a speaker only, as in the conventional model, but he gets some new functions in the Inverted Class Room Model. In this new model the lecturer delivers a lecture in the X-Cast, acts as a host/mentor in the Plenum and
as a coach in the *Exercise Course*. Fig. 2(b) shows the different types of interaction between lecturer and students and among students in *Plenum* and *Exercise Course*.

3. **Structure of a topic**

Following the considerations of the previous paragraphs each topic contains the following parts/elements: (1) **X-Cast**: Any type of information about the topic in a presentation that is recorded in a computer file, includes some practical exercises and can be provided before the *Plenum* and/or *Exercise Course* take place. Students shall be able to watch this media before visiting the *Plenum*. **(2) Transcription** of the content should be provided in addition to the *X-Cast*. This can be the slides the presentation is based on or a transcription of the blackboard while using a Pencast or similar technology. **(3) Additional Information / Documents / Further Links**: For each topic a set of additional documents like sample code, references, standards or further links to additional online resources might be necessary. These documents shall be provided as annexes to the topic's media. **(4) Errata**: Since the production of *X-Cast* or similar online resources is time consuming the number of changes is limited. Therefore errata of known issues in the media shall be provided as an annex to the topic's media. **(5) Homework (Optional)**: Exercises can be marked as mandatory. In this case they are in fact considered as homework and there is a need for a procedure on how a homework solution can be submitted and feedback can be given on it.

4. **E-Prototype**

4.1. **Requirements**

Before the course was executed in winter semester 2012/2013, an E-Prototype (IT-System) for supporting the team during the course was implemented. To ensure the prototype fulfils the requirements of lecturers and students a formal collection of requirements was done. The full list of requirements can be found in [3]. The most important requirements are:

(1) **Web technology / platform independence**: System shall use web technology and should be able to deliver contents to current web browsers on any popular platform. This includes not only using web standards but also a way to provide video data for many different platforms. (2) **Multi user access**: System shall support different users working on the content. This includes sharing data and locking mechanism to ensure there is no collision during the content creation. These are general document management system functionalities. (3) **Homework submission**: System shall support submission and correction of homework as well as giving feedback on submitted homework during correction. (4) **Replaceable User Interface**: System shall have a facade/face that can be replaced easily to allow using topics in different contexts or courses and for different target groups. (5) **Syndication**: System shall support modern syndication technologies to allow promotion of the course. (6) **Release timer**: System shall support timer controlled step-by-step release of the content during the semester.

4.2. **Architecture of E-Prototype**

The E-Prototype was designed as a distributed IT system serving two different types of users. The authors are in charge to generate the course material. In our use case lecturers use the system taking this role. The consumers use the system to get information and use them to learn. In our use case the students take this role. System is split up in several service providers (and the corresponding servers) these are organized in three layers (see Fig. 3(a)): (1) **Back End / Authoring Layer** includes all functions to manage the content and keeping and sharing it during authoring phase. (2) **Data Store / Middleware layer** includes all functions to provide data and keeping it online during execution phase. (3) **Faces / Front End layer** includes all functions providing a user interface.

A key feature in this architecture is to split content providing and user faces. This allows using different faces for different target groups and contexts and therefore is an enabler for using content in reassembled way for different types of courses.
Following the definition of layers the following service providers were defined: (1) **Document management system** provides functions for collaborative development of course material and support authors by file sharing, locking and versioning mechanisms. (2) **Video provider** provides content delivery for video files to many different client platforms like different web browsers, operation system and devices (e.g. personal computer and mobile devices like table computer and smart phones). YouTube was chosen as a Software-as-a-Service (SaaS) to cover a wide range of today's and future devices. (3) **Content provider** provides content delivery for downloadable files and data access related to topics. It can provide content in several formats requested by clients. (4) **Web server** provides web pages / user interface as a face for the system to allow user specific online course rooms. Details about chosen technologies and implementation of the system can be found in [3].

5. Execution

The developed prototype fulfills the requirements collected in the beginning. The implemented content provider was used, maintained and extended during execution of the course and is stable now. The source code of the content provider was made publicly available; the latest version of the source code is available under [2].

5.1. **Moodle Course Room**

One face for to the content provider is a Moodle course room [6] seen in Fig. 3(b), which was implemented as the main platform to provide access to the course material (video, slides, etc.) and to submit/collaborate and correct home work for all students at Ingolstadt University. The Moodle platform of Ingolstadt University was used to establish the course room, because it is linked to the central directory server and all students already have an account here. The content is just linked and is provided by the implemented content provider.

5.2. **Public Access Course Room**

As a part of RiFLE project [1] funded with public money the content of the course was also made publicly available on the web page of i2cm lab. This second face for the content provider can be accessed here [4]. As this face is a special implementation, the user interface is fully generated by the web server on access based on the data got from the content provider. The content itself is also just linked, like in the Moodle course, however in this case the frame is generated automatically. A detailed overview on the different faces can be found in [3].

6. Conclusion
As a conclusion a short overview on the result from testing the new approach during the semester and a prospect based on the lessons learned during the semester is given.

6.1. Test Result

During the semester some students involved in the course complained about the work-load, because following the scheme of the course and the submission of homework restricted the way of their self-organisation. To ensure relevance the usage statistic of video provider YouTube was taken on 2013/02/26 (close to the examination). YouTube counts views from different (unique) users only. Statistics shows a core group of 500 students watching the videos related to topics which are relevant for homework and/or exam. This shows that students are accepting the way of imparting knowledge and use online ScreenCasts for preparing Plenum and Exercise Courses. For some more common topics bigger numbers were measured, showing the relevance of course topics. For the purpose of course evaluation these numbers are not relevant. Details on the statistics can be found in [3]. In the final evaluation done by the faculty the test course was considered as successful. The rate of fails in exam was reduced from over 45% to 31.5%. Since the level and the structure of the exams is the same since 2010 the comparison of these numbers is valid. This shows the approach applied in the course was an effective way of teaching. Unfortunately, it was not possible to identify if this decrease was a result of using new media or if the comprehensive system of Plenum, exercises and homework made students more engaged in the several topics.

6.2. Lessons Learned / Prospect

Following the feedback of involved students some adjustments to the course content were made, e.g. the description of homework tasks is now offered as extra documents in addition to the description on the slides and in the ScreenCast. This document also contains a check list to ensure students can do a self-evaluation by ticking-off this listed point before submitting.

The E-Prototype was made stable during this pilot semester and is today used for additional lectures in mathematics, statistics and computer aided design.

References

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