

# Concepts of Blended Learning for Different Content Types

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**Abstract.** The immense effort for creating e-Learning content is one of the limiting factors in the proliferation of e-Learning technologies. In the present paper we therefore describe two concepts for Blended Learning that try to achieve a good balance of creation as well as maintenance effort and the benefit for the students. These two concepts are applicable for different classes of courses. A text-based concept is described for courses dealing with fundamental and mature contents and a recording-based concept for more advanced topics with a high alteration rate. The concepts as well as their technical implementation and evaluation results are presented.

**Keywords:** course types, LaTeX, recordings, moderate creation and maintenance effort

## 1 Introduction

It has become a common practise to support learning with different kinds of electronic systems, no matter if it comes to face-to-face study paths with full face-to-face lectures or virtual study paths without any face-to-face phases. The spread of electronic support reaches from just preparing digital learning material to providing complex learning management systems (LMS) implementing elaborated didactic concepts. There are many studies showing the advances of e-Learning as well as evaluating e-Learning challenges and how to exploit its full potential, e.g. [6].

Of course a lot of research has been done in this area so far. Existing and implemented concepts and studies cover all aspects of e-Learning. There are among others theoretical concepts dealing with special issues, research reports on strategies and concepts improving Blended Learning like [2], or methodologies for designing higher-education by implementing complex systems, e.g. [1].

However a lot of educational institutions suffer from a lack of resources, concerning financial and personnel support, and lots of known concepts and systems cannot be set up or used due to these restrictions. In spite of that it should be possible for smaller institutions to set up a quality system supporting teaching and learning in a satisfying way.

The overall aim of this paper is therefore to present an approach that is well-elaborated, combining traditional face-to-face teaching and evolving technical possibilities, covering important factors of teaching and learning and most importantly not having an immense need for additional resources. The technical basis we used to implement our concept is an Open Source LMS, in our case Moodle<sup>1</sup>, which is used university-wide<sup>2</sup> and administrated by one person employed part-time. The presented concepts should therefore be easily adaptable and practical for a lot of institutions without special claims on resources.

The nature of Blended Learning always depends on various factors like scope of face-to-face and virtual phases as well as obtainable working time. Since having a unique concept for every single lecture cannot be efficient we were developing a concept to transform plenty of practises, conditions and requirements to a few well-elaborated but homogeneous forms.

Needless to say there are some general conditions Blended Learning should meet and that therefore should be covered by every instance of the desired concept. Put another way, we can define those conditions as general goals to be accomplished with our concept in order to make it usefully applicable. Those goals have to be determined at least from two sides, the lecturers' and the students' side.

Concerning the lecturers' side it is indispensable that lecture notes, respectively provided learning material, can be created with little additional effort and maintained with even less effort. In addition there should be a productive environment for lecturers to absolutely eliminate dispensable time invested in the building process but extend the time that is available for qualified supervision of students. Taking a look at the students' side, an important demand is the request for printable material. Despite the various advantages of online content, students have a general need for printable material. Naturally students in Blended Learning courses require familiar advantages of e-Learning as well. Another goal we added that cannot be accredited one of the sides is the possibility to integrate the result into our university-wide LMS.

The concept we were developing should cover a wide, though specific span of Blended Learning forms. To avoid restrictions due to special characteristics of study paths and courses and to allow a detailed concept fitting the needs of all participants, we decided to split our courses into two different types by the means of different content types that are presented in the courses.

It is a practical experience that on the one hand there are courses having almost the same content over the years without being obsolete, and on the other hand there are courses that can hardly come through one semester without the need to be changed. Depending on the subject, there are usually courses or course fragments containing very fundamental and mature issues. The content of those courses is therefore almost

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<sup>1</sup> Official Moodle-Website <http://www.moodle.org>

<sup>2</sup> Virtual Campus of the University of Bamberg is available at <http://vc.uni-bamberg.de/moodle>.

static with a quite low alteration rate. Of course most subjects also have courses covering more advanced and therefore often newer issues, e.g. actual research topics and insights. Permanent monitoring of treated topics and subsequently a high alteration rate are essential to uphold the quality of those courses.

Since it has been shown that delivering well-elaborated learning material itself is not sufficient to provide high-quality teaching and that there are other factors like monitoring the students' success and understanding that need to be concerned, we are adding auxiliary components to our courses. There are various analyses on how to ensure profound high-quality teaching, e.g. [4]. As mentioned before there are different factors like time and resource restrictions for a lot of smaller educational institutions that will not allow a widespread approach to cover all factors desirable. Therefore we are trying to consider the most important factors like ensuring profound understanding and supporting the students' ability to critical self monitoring and review as far as possible by adding further components —such as self-test— to our concept for both types of courses.

In the following two sections the differing concepts for the two types of courses as characterised above are explained and reasoned. As finally shown in section 4 the concepts turned out to be successful and can easily be adapted.

## 2 Text-Based Courses

Like outlined above, one type of courses are courses containing fundamental issues setting up the base for following advanced courses. It is obvious that basics of a specific well delved subject do not change very often or very fast so that the presumption of almost static courses is realistic. The idea for this kind of courses is to structure the subject matter like a book, to take the specific characteristics mentioned into account. Accordingly it is feasible to provide the subject matter in different digital forms.

To realise this concept we needed a building tool that is at best commonly known, easy to use and of course providing the desired outputs. Conceivable outputs include especially PDF- and HTML-documents. For this reason we evaluated a “single source, multiple publishing” approach that builds different kinds of output from one XML source [3]. An approach like this seemed to bring the brightest prospects. Unfortunately creating and updating the text-sources directly in XML is pretty inconvenient. The effort needed to maintain text itself is additionally amplified, e.g. due to lots of formulae and graphics to be included. At the same time we also verified the idea to provide the learning material in different digital forms by questionnaires handed out to our students. The result strengthened the assumption that our web server statistics allowed. Students not only definitely preferred printable content but also saw no need for additionally offering the curriculum as interactive online content.

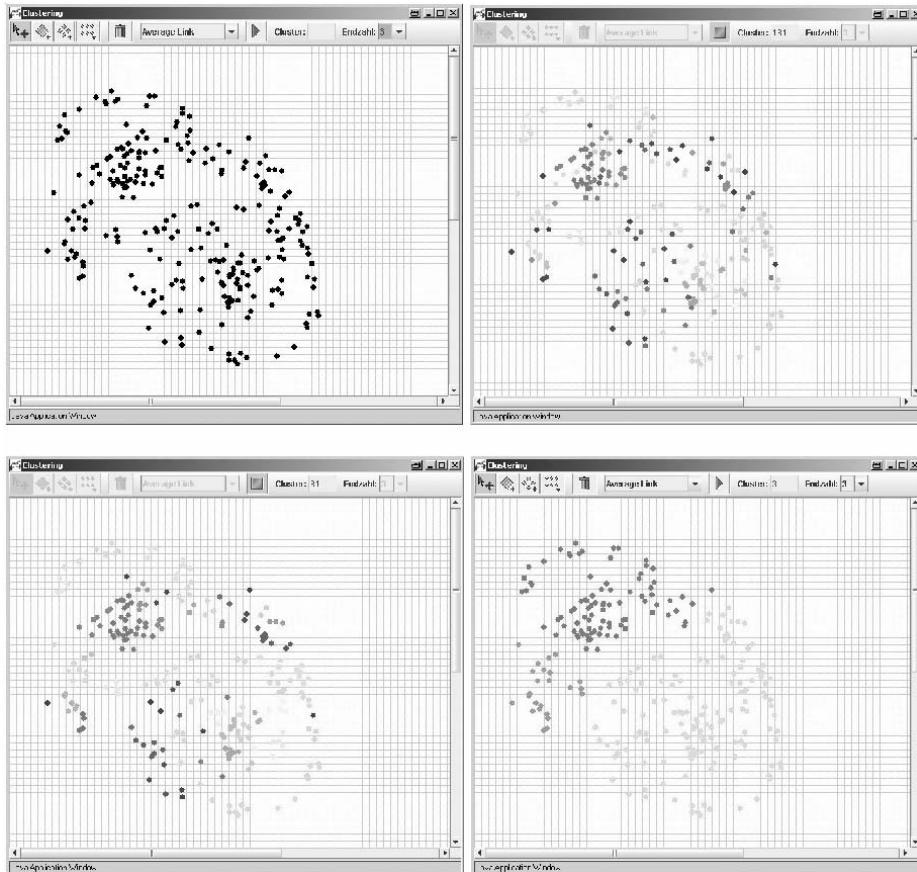
All these factors and experiences lead us to discarding the “single source, multiple publishing” approach in the end and brought about the decision to offer PDF-documents as learning material concerning the curriculum. The decision for PDF-documents is motivated by the fact that the PDF-format is an established platform independent format that has good prospects. PDF already offers mature possibilities to provide comfortably structured and interactive documents. Besides, further development is already taking place and in particular the interactivity options are expected to be improved and increased in future versions. The following conclusion to use LaTeX as building tool was just a logical step. LaTeX is a well known and widespread format especially for academic writing and it also provides very good integration of formulae and extensive possibilities to include graphics.

We employ a specific format that provides additional benefits, e.g. marginalia, which are complemented to improve the structure and clearness of the text. The whole material is also completed by a wide index and an extensive bibliography where literature is directly linked if possible. Besides, we focus on adding lots of additional links to benefit interactivity; there are anchors referring to further parts of the learning material, concrete links to related parts of our LMS and a large number of links to external websites. We are convinced that generating PDF-documents from LaTeX-sources is a good choice because there is the possibility to have a really comfortable interactive version of text. PDF-documents therefore can be used as online and print version all at once, providing the benefits of both versions. Generally the PDF-documents are uploaded to our LMS and provided to the students this way.

The concept to use the material of those courses embraces two phases. First, students are working through the provided learning material on their own. This approach replaces the normal face-to-face lectures and therefore, as assistance, a schedule showing the optimal allocation of learning is handed out to the students. Second, to supplement the self-organised learning there are weekly face-to-face meetings with the lecturer. Mainly the material scheduled for the last week is discussed in these meetings, but the discussion is also open for special issues or questions emerged.

To provide additional interactive parts to our text-based courses and encourage the students' learning possibilities there are additional components supporting a broader view on the content of the curriculum and expanding alternative ways for students to learn and understand the essence of the subject. We are adding two interactive components: Java Web Start applications and self-test tasks.

**Java Web Start applications** are an important part of our courses – especially where a profound understanding of sophisticated concepts is desirable. We figured out that there are several concepts in each course where such an application can provide useful visualisation and additional understanding. Applications are uploaded to our LMS and provided within the system. Due to the standalone nature applications are independent from any system and can be used not only on our current LMS but on probably different future versions too.



**Fig. 1.** Progression of a clustering applet visualising a clustering process

Depending on the content of the courses there is a variety of applications provided. To name but a few, one course we are offering is Information Retrieval [5] and we are e.g. providing applications on Recall and Precision graphs as well as applications to explain the process of stemming methods or to combine understanding and implementation of algorithms for pattern matching. As an example you can see the time progress of an application visualising the clustering process of a specified clustering algorithm in figure 1.

**Self-test tasks** represent the second component we chose to provide additional options and interactivity for students. Self-test tasks constitute an instrument for students to get an estimation of their current knowledge and understanding of important concepts as well as a possibility to improve their current state of knowledge by accomplishing the provided tasks. Self-test tasks are normally realised as a sequence of multiple choice questions. The type of questions ranges from questions on theoretical aspects to sophisticated computations.

Virtueller Campus

VC UniBa » IR6 VAWI » Tests » Signaturen - Signaturbäume » Versuch 1

Signaturen - Signaturbäume - Versuch 1

Seite: 1 2 (Nächste)

1

Erreichbare Punktzahl: 1

Gegeben sei der folgende Signaturbaum:

$N_1$	
111011111	$N_2$
001011110	$N_3$

$N_2$		$N_3$
100101010	$N_4$	000101110
011101010	$N_5$	001101110
$N_4$	$N_5$	$N_6$
1001010010	$N_6$	0111010001
1001001010	$N_7$	0111000101
$N_6$	$N_7$	$N_8$
000101110	$N_8$	0011010110
000101010	$N_9$	001101010
$N_9$	$N_{10}$	$N_{11}$
000101110	$N_{10}$	000101010
001101010	$N_{11}$	$N_{12}$

Wie läuft die Suche nach dem Datensatz 0001011110 ab?

Wählen Sie mindestens eine Antwort aus.

a. Die Anfragesignatur 0001011110 passt in  $N_1$  nur zur Signatur von  $N_3$ , so dass wir den Pfad zu  $N_3$  weiterverfolgen. Innerhalb des Knotens  $N_3$  passt die Anfragesignatur nur zu  $N_6$ . In Knoten  $N_6$  passt die Anfragesignatur schließlich zum Datensatz  $N_{12}$ .

b. Die Anfragesignatur 0001011110 passt in  $N_1$  nur zur Signatur von  $N_2$ , so dass wir den Pfad zu  $N_2$  weiterverfolgen. Innerhalb des Knotens  $N_2$  passt die Anfragesignatur zu  $N_6$  und  $N_7$ . Im Knoten  $N_7$  passt die Anfragesignatur zu keinem der Datensätze. In Knoten  $N_6$  passt die Anfragesignatur schließlich zum Datensatz  $N_{12}$ .

c. Die Anfragesignatur 0001011110 passt in  $N_1$  sowohl zur Signatur von  $N_2$  als auch  $N_3$ , so dass wir die beiden Pfade zu  $N_2$  und  $N_3$  weiterverfolgen. Innerhalb des Knotens  $N_2$  passt keine Signatur, wir können also auf eine weitere Suche in diesem Zweig verzichten. Innerhalb des Knotens  $N_3$  passt die Anfragesignatur zu  $N_6$  und  $N_7$ . Im Knoten  $N_7$  passt die Anfragesignatur zu keinem der Datensätze. In Knoten  $N_6$  passt die Anfragesignatur schließlich zum Datensatz  $N_{12}$ .

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Fig. 2. Integrated self-test task on signature trees

Other than Java Web Start applications self-test tasks are generated and provided directly in the LMS. This approach brings a potential risk concerning possible changes in the use of the LMS, but because our actual system offers a backup functionality that exports selected data to XML we are willing to take the risk of doing some migration work in case of a change of the system. Besides, the LMS offers wide evaluation possibilities of test results, a factor that also confirms our considerations.

Abiding with the Information Retrieval course there are, among others, self-tests on principle Information Retrieval questions and models of Information Retrieval like the vector space model or the binary independence retrieval model. In figure 2 you can see a screen shot of a self-test task on signature trees. The specific problem is searching for a precise signature in a given signature tree; there are 3 pre-formulated answers to choose from.

The main goal of integrating and providing PDF lecture notes, Java Web Start applications as well as self-test tasks as parts of one course in our overall LMS is therefore to meet the requirements of students and lecturers all at once: providing well elaborated and printable lecture notes that are easy to create and modify as well as a balanced degree of interactivity to benefit students' success.

To round the concept for text-based courses we are providing weekly exercise lessons. The exercises mainly consist of implementing the concepts presented and learnt during the lecture-like parts of the course. We consider this as an important part of

our concept, respectively courses, because students learn to study and apply the theoretical concepts practically.

As a further possibility students get the chance to collect bonus-points for the exam concluding the course due to biweekly tests that are offered. In total there are 5 voluntary tests with tasks about different concepts that are part of the course and 4 points can be reached each time. The best 3 test results are added to the exam result if the exam is initially passed. Since the best score in the exam is 90 points no matter if bonus-points are considered or not students can markedly improve their exam results by collecting bonus-points. Our LMS offers a good support for those tests. The detailed test is provided on our LMS and students are first able to download the test and build their solution wherever they want to. Second, they are able to deliver the results directly in the system by an upload mechanism. Lecturers are then able to view, judge and score the students' solutions also directly in the system, while students can check their test results and score as well as a usually provided suggested solution after the lecturers' scoring is completed. The thoughts behind those tests are that students are really getting into the subject not just shortly before the exam but during the whole semester because they need to understand the content of the course to process the tests. Of course this might not apply to all students because it is a voluntary offer but normally students are motivated to do the tests in order to improve their exam results this way.

Looking at the whole concept at a glance we are trying to regroup the face-to-face phases. That implies reducing face-to-face phases where they are not absolutely necessary, e.g. to work through provided learning material, but extending face-to-face phases where further supervision and contact can be useful, e.g. by additional exercises..

### **3 Recording-Based Courses**

In contrast to courses consisting primarily of fundamental and therefore static content, there are courses containing current standards and systems as well as actual research topics and results. Since we attempt to keep our courses up-to-date, these are obviously courses that need to be changed more often. For this reason an appropriate building and update strategy is needed to keep the effort within a manageable limit. As a consequence we were looking for an approach that allows generating and providing courses very easily with barely additional tasks apart from delivering the face-to-face lecture itself. Obviously this brought us to Rapid e-Learning and we started pursuing an appropriate Rapid e-Learning approach.

In contrast to text-based courses we were keeping the traditional way of face-to-face lectures attended by students for recording-based courses. We chose to record the lectures [7,8] and provide the recordings afterwards because the lecture has to be delivered anyway and if it can be recorded in the same time there is apparently almost no need for additional time and effort. The thoughts behind this concept are to provide

the lectures for students even after the face-to-face lectures were actually delivered. This way, recordings can be used for post processing or exam preparations. Students can run the recordings to repeat the whole curriculum or just parts they probably missed or still have questions on. Of course no one is directed to use the recordings at all, it is a voluntary offer. We had thoughts about a smaller number of students attending the face-to-face lectures at the beginning because students could use the recordings instead of taking part in the lectures but our thoughts were proven wrong. Students are still attending the lectures and there is no noticeable smaller number except for those missing due to inevitable conflicting dates with other lectures. So far we see this as an advantage of our recordings since they are attenuating these problems.

The requirements and preparations needed to accomplish this approach are neither demanding nor expensive. First of all lecture notes are created as slides. There is no need for any additional formatting or settings, and since slides are used as base to deliver the lectures anyway the slides can be created as usual. Furthermore the plain slides can be stored as PDF-documents so that they can be provided as additional material for students to meet the requirement of printable material.

The actual recording process takes place when the face-to-face lecture is delivered. The lecture is thereby delivered as usual but the lecturer records his lesson. The technical equipping needed to run this system is imaginably low: A tablet PC connected to a projector is used to display the slides and to provide additional information and assistance on the slides as well as extra slides created off the cuff if desired, we are using the Rapid e-Learning tool Lecturnity<sup>3</sup>. The only additional requirement is an ordinary web camera. The camera records a video of the lecturer while delivering the lesson, including the audio stream. Of course there are restrictions concerning the quality of the recordings if recording is done with a simple web camera, but since the recording result is integrated into and provided on our LMS the restrictions correspond with the restrictions due to bandwidth and storage (in our setting a recording of a 90-minutes lecture requires about 120MB).

Lecturnity is able to combine the recordings of the web camera and the recordings of the slides. Furthermore thumbnails of the slides are displayed as table of content and can be used to navigate through the video. The standard output format is a proprietary format, but there are lots of standard outputs possible. It is e.g. possible to produce Flash- or SCORM-files.

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<sup>3</sup> Official Lecturnity-Website <http://www.lecturnity.de>

**1. Schritt: Bildaufbereitung**

- Beispiel: 3 Farbenen.
- H = Horizontale Gruppierung.
- V = Vertikale Gruppierung.
- Im Beispiel entstehen folgende MCUs:
  - $MCU_1 = d^1_{00} d^1_{01} d^1_{10} d^1_{11} d^2_{00} d^2_{10} d^2_{00}$
  - $MCU_2 = d^1_{02} d^1_{03} d^1_{12} d^1_{13} d^2_{01} d^2_{11} d^2_{01}$
  - $MCU_3 = d^1_{04} d^1_{05} d^1_{14} d^1_{15} d^2_{02} d^2_{12} d^2_{02}$
  - $MCU_4 = d^1_{20} d^1_{21} d^1_{30} d^1_{31} d^2_{20} d^2_{20} d^2_{10}$
  - ...
- Beim Dekodieren wird das Bild MCU-weise zur Ansicht gebracht.
  - korrekte Farbdarstellung, auch bei nicht vollständig dekodiertem Bild.
- Nach der Bildaufbereitung besteht Bild aus:
  - Dateneinheiten zu  $8 \times 8$  Pixel, Reihenfolge durch MCUs festgelegt, Abtastwerte z. B. 8 Bit je Ebene (= Werte: 0 - 255)

Prof. Dr. Andreas Henrich - 4. Bildformat (S. 2)

Fig. 3. Screen shot of a recording available for students

To view the standard output format a free player is available. To make it even simpler, we are providing the player on our LMS, therefore students only need to download and install the player. The technical requirements to install the player are very low, so that except for very few cases no additional costs occur for the students. There are some students having problems due to video configuration, but the rate is below 1 percent. In total the lecturer only needs about 5 to 10 minutes of extra time for each lecture to import the slides into Lecturnity, to export the final recording after the lecture and to publish the recording in the LMS.

In figure 3 you can see a screen shot showing the result of the recording that is available for students after the face-to-face lecture, viewed with the corresponding player. As you can see the lecturer, the slides and the table of contents for navigation are visible all at once.

The concept of recording-based courses is also supplemented with exercises and tests to collect bonus-points for the exam. The realisation of these two features is basically like in text-based courses.

### 3 Evaluation

After extending the scope of our Blended Learning concept, we were reorganising all our provided courses and mapping each to the types described above. The resulting distribution is quite balanced – there are 7 courses that we regularly provide, 2 of them are basic courses and therefore provided as text-based courses, 4 of the courses lie in the advanced field and are realised as recording-based courses, and 1 of the courses has basic and advanced parts and is therefore realised as a hybrid form.

Evaluation concerning the lecturer-side is restricted to a self-critical review at the end of each semester, showing that the deliberations concerning needed effort and available time were generally correct. Since nobody but us is using the concept by now there are no further evaluation results available.

Concerning the view of students, the two introduced course types are evaluated against different criteria at the end of each semester. We are presenting exemplary evaluation results of one text-based and one recording-based course that took place in the last semester – the results are based on 25 evaluated questionnaires.

There are some general questions that are similar for text-based and recording-based courses. Students were asked general ratings for the lecture, respectively the lecture-like part, and the exercises; the scale for the general questions reached from 1 (very good) to 6 (very bad). The grading for the lecture concept as a whole and the associated exercises ranked from 2.1 to 2.6 for text-based courses and from 1.6 to 2.0 for recording-based courses.

The special focus for text-based courses was on questions about organisation and structure of the learning material and the weekly face-to-face meetings. The scale available reached from 1 (disagreement) to 4 (agreement). The learning material was rated in different criteria, e.g. structure and understandability as well as personal estimation on how good the learning material covered the underlying area, and how helpful the learning material was for understanding concepts of that area; the average values of ratings in this area reached from 3.1 to 3.8. Concerning the weekly face-to-face meeting students basically had to rank the degree of help that was offered by these meetings; the average value was 3.1 in this area.

The focus for recording-based courses was of course on rating the use of recordings. The plain result was that all participants were using the recordings, some for equalising missed lectures, some for post processing difficult parts and some for exam preparation.

Drawing an overall resume all values are positively above average and students seem to be comfortable with the concept of text-based as well as recording-based courses.

After mapping our Blended Learning courses successfully to the evolved concept, we were thinking about further efforts and developments. Since we are participating in a

joint offer of a virtual study path<sup>4</sup> it was obvious to transfer our existing concept to the courses offered in this environment. We realised that the concept could easily be adapted to virtual courses and there is actually almost no alteration needed.

Concerning the text-based courses all parts of the courses could be used just the way they were, because the virtual courses are provided via our LMS too. The PDF lecture notes can be provided as usual and the same applies to Java Web Start applications as well as self-test tasks. Solely the weekly meetings to discuss concerns or questions emerged for students while working through the learning material are dropped. Instead of arranging face-to-face meetings the discussions are entirely moved to the forums included in our LMS.

Transforming the recording-based courses slight changes or possibly additional time is needed. In principle the recordings can be provided as usual and the same applies to the additional lecture notes provided to students. The decisive advantage is that the recordings make students of virtual courses feel like they are actually attending face-to-face lectures. The problem is admittedly that the recordings have to be created although there is no face-to-face class. In our case this problem does not occur because the recording-based courses of the face-to-face study path are identical to the recording-based courses of the virtual study path so that we can reuse the recordings arising out of the face-to-face lectures. More concrete, the face-to-face course is given in the winter semester and the corresponding recordings are used for the virtual study path in the following summer semester. We are aware that this a special case and that the additional time needed to create the slides and recordings without a corresponding face-to-face lecture can turn out to be a problem due to time restrictions. Questions and discussions normally covered during the face-to-face lecture are moved to forums for recording-based virtual courses as well.

Both types of courses therefore proceed on the assumption that the lecturer spends time on supervising the forums and answering questions arising in an appropriate time. Obviously the face-to-face exercises have to be dropped for both kinds of courses because there is no possibility for students to attend such classes. Nevertheless it is possible to offer the tests to collect bonus-points for the exams as usual so that students get for once an idea of practical issues related to the theoretical concepts learnt before.

Detailed evaluations have shown that students are pretty satisfied with this approach. Evaluations are taking place at the end of each semester and each proceeded course is evaluated properly. The evaluation results presented below refer to two text-based and one recording-based course of the last two semesters, that is about 40 fully completed and evaluated questionnaires. We restricted the results to the last two semesters to present the results as actual as possible. Evaluation criteria were on the one hand criteria concerning the quality of supervision, e.g. supervision of content-related or technical problems as well as organisational support. On the other hand criteria

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<sup>4</sup> The virtual study path is a joint offer of the University of Duisburg-Essen and the University of Bamberg, further information is available at <http://www.vawi.de>.

concerning the content of the courses, e.g. the intermediation of knowledge, comprehensibility or structure of the presented content were evaluated. The evaluation scale allowed grading every criteria on a scale from 1 (low) to 7 (high), additional space for comments on especially positive or negative features as well as further comments was available.

Although the students admitted that the effort needed to pass the courses was above average by tendency, we got very positive responses on average. All criteria concerning the quality of supervision were ranked very high, at least 6.0 or above, above all courses. There is no recognisable difference between recording-based and text-based courses. The criteria concerning the content of the courses are rated little worse but still very high relating to the evaluation scale. Concrete values vary from 5.5 to 6.7 for text-based courses and lie closely around 6.0 for recording-based courses. Analysing the spaces for free comments it became obvious that especially the provided recordings were appreciated when looking at the recording-based course. There were a few students that had start-up difficulties because the learning material for recording-based courses is organised as a structured collection of bullet items and not continuous text, but the recordings and possibilities available by forums smoothed these problems. Concerning the text-based courses lots of students commended the systematic book-like structure of the learning material. Some students always go to the bother of suggesting concrete improvements and as far as it is possible we are trying to consider the suggestions for the next semester.

The most salient overall result was that a few simple but effective facts were mentioned very positive across all courses. Extremely positive responses gained the fact that the lecturer itself was actively attending the forum discussions and answering questions of every kind. The short response time provided by lecturer and tutor is also a circumstance that was appreciated a lot.

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