

# **New Features for eLearning in Higher Education for Civil Engineering**

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**Abstract:** This paper describes an eLearning approach to distant teaching a master course for civil engineering students. The course has been implemented using a novel eLearning system, called WBT-Master. Typical learning platforms provide only standard tools without taking into consideration special needs of such specific user groups like Civil Engineering students. The aim of this project was to extend the WBT-Master functionality to support the specific eLearning paradigm. The paper describes such specific features and processes and evaluates the experience gained during practical system usage. Subsequently the benefits of the approach are summarized and discussed. It should be especially noted that the recommended changes have made the eLearning environment substantially more useable and have increased the students' acceptance.

**Keywords:** eLearning, course management system, civil engineering

**Categories:** TH.AP; TO.6

## **1 Introduction**

“The World Wide Web offers educators a new medium to deliver teaching and learning material – one which bring new and exciting ways of learning, and an alternative to traditional teaching techniques” [Allen, 98]. Since then a number of eLearning platforms and course management systems have been developed and successfully established in Higher Education. But have those technical equipments fulfilled the high expectations of the end users?

It is important to note that computers cannot improve the knowledge acquisition (i.e. learning) per se. Learning is a basic cognitive process, which has to be carried out by the learners themselves. This means that learning is an active process from a learner's perspective. Knowledge and understanding is constructed by the learner [Holzinger, 02]. Not only transmitting information, but also engaging them in authentic tasks - “Learning By Doing” as Dewey (1916) argued - will be the key for a successful

learning approach. According to Vygotsky [Vygotsky, 78], the relationship between interaction and learning can be summarized in three sentences:

- Learners' achievement level depends on what they already know (previous knowledge);
- The mechanism that delivers knowledge is an interaction;
- The goal of learning is interactive problem solving.

Thus, the fundamental idea of eLearning is to help learners become actively engaged in collaborative work via various computer-supported processes. In other words, eLearning potentially enables better didactic scenarios and in particular it increases motivation [Holzinger, 99] to enhance traditional learning methods.

Graz University of Technology has profound experience in building eLearning applications for computer science students [Maurer, 96]. From a perspective of eLearning, students of another field of study have specific needs sufficiently different from needs of computer science students.

The paper presents a project aimed at identifying an eLearning training paradigm suitable for university courses in the specific field of Civil Engineering.

## **2 The eLearning project iVISiCE**

Since the end of 2001 the eLearning project iVISiCE (interactive Visualizations in Civil Engineering) has been used to support the study of Civil Engineering at Graz University of Technology [Ebner, 02]. Originally the aim of the project was to investigate the possibilities of WWW usage in Structural Engineering Education.

Due to the fact that a student of civil engineering has to gain an intuitive understanding of structural behaviour the education is strongly based on visualizations. Brohn [Brohn, 83] expressed it in some few words: "The language of intuition is visual, just as the language of analysis is abstract and symbolic". Bearing that in mind, the eLearning venture focused on three major research topics – communication, interaction and visualization.

Consequently a great number of Web based animations, visualizations and interactive Learning Objects (ILOs) have been developed to visualize and to simulate highly complex processes [Ebner, 03]. A lot of experience has been gathered in the field of using Multimedia in Higher Education. Especially in the field of Civil Engineering, where sketches and drawings are absolutely necessary to explain complex engineering models, the use of these new technologies is still rare. Teaching the basics of e.g. structural analysis is done primarily by using mathematical descriptions of physical laws and some graphical methods [Walder, 05].

In combination with the multimedia project of Graz University of Technology the lecture course "Structural Concrete" was selected for an implementation in an eLearning environment. The basic content of the master degree course is the design

and construction of reinforced or pre-stressed concrete structures using the European Standard Norm (EC2) [Sparowitz, 01].

On the one hand the project iVISiCE concentrated on developing well didactical content and on the other hand this content was implemented in a course management system, which is made available by the computing department of the University. Initially this combination appeared to be quite successful. Subsequently, the gap between the sophisticated and up-to-date content [Holzinger, 03] and an obsolete, rigid content delivering platform became bigger and led to a dissatisfaction of both end-users, lecturers and students.

Finally, the system support team decided to follow a new paradigm (see below) where a content delivering system can be adapted and upgraded in the same way as content complexity and user engagement are increasing.

### 3 The WBT Master

WebBasedTraining (WBT) - Master server holds a collection of so-called Training Objects (<http://coronet.iicm.edu>). A typical example of such training objects is an e-Book, but this is not the only type of training objects available. Discussion forums, chats, quizzes, virtual laboratories and project management rooms are also training objects which can be created on the WBT-Master server.

Each training object has an appropriate URL and implements a particular training paradigm. For example, students are supposed to answer questions if they use an "Examination Room"; upload and discuss reports, if they use a "Thematic discussion"; develop a project in collaboration with colleagues and if they use a "Project Management Room".

Moreover, training applications implemented by the means of PHP and/or Servlet Technology on other servers may be also treated as WBT-Master training objects. In this case they are called "portals".

Training objects can be combined with a new single entity by the means of two paradigms - called "Training Course" and "Personal desktop". A training course is a combination of training objects selected for a particular study. A training course also provides some additional communication and user administration tools.

Short descriptions of some training objects offered by WBT-Master are provided below:

- *E-Book* is the most trivial training object. It can be seen as a number of documents combined into reusable, navigable collections, and an e-Book provides convenient document accessing facilities (table of content, map, search, bookmark, etc.). Additionally, an e-Book provides such communication features as annotation [Helic, 04] and discussion plus some

user-control features such as map of visited pages and of course results of answering embedded questions;

- *Discussion Forum* supports a rather well-known "News Group" discussion paradigm where messages can be published on a server and organized as discussion threads consisting of "Follow Up" messages. Of course, WBT-Master provides some additional features as ranking messages, presenting them in accordance with rankings, inline attachments and so on;
- *Discussion Room* supports the same paradigm as the Discussion Forum, but has a number of additional features: bookmarks and links between messages, annotations, ranking messages by teachers and having alternative discussion structures, classifying messages by authors;
- *Meeting room* can be used for arranging virtual meetings by discussing shared documents using pointer and chat facilities. Meeting session can be saved and printed out as meeting minutes;
- *Thematic Discussions* are often used for learning by doing [Dewey, 16]. The teacher simply defines a number of topic (themes) and provides referential materials relevant to each topic or to the subject as such. Students are supposed to apply the knowledge and do some practical work that is uploaded to the server. Student uploads are discussed, commented and evaluated by a teacher and/or other students;
- *Project Management Room* also deals with uploading of students practical samples onto the server and discussing/reviewing them. The only difference is that the students work in collaboration by creating small teams. Uploads are structured not by topics but each team has a sort of private area where all uploads are available and can be discussed and/or reviewed in private;
- *Personal Lockers* are rather similar to Project Management Rooms except that this paradigm is used for individual practical assignments;
- Working with the so-called *Examination Room*, teachers define a number of questions relevant to a certain training topic, and combine them into groups. Each student is granted one attempt to make the quiz within particular time slot (e.g. one hour). The list of questions is randomly generated from predefined questions; students work through the questions and gather some points for correct answers. The object can be used as for real examinations as well as for temporary control of working with other materials;
- For real examinations as well as for temporary control of working with other materials;
- *Tutoring Sessions* and *Mentoring Sessions* are used for online/offline step-by-step explanations of most difficult topics. Teachers select materials from the system and provide verbal explanations using a special pointer or whiteboard.

If we now compare WBT-Master with existing eLearning solutions, we can point out a number of essential advantages:

- *Rich Functionality*. Normally, only the e-Book component covers the whole functionality offered by such well-known systems as WEB-CT, Blackboard, ELS and Lotus Notes;

- *Flexibility and Customization*: these features, which are desirable for any other eLearning solution; are an inherent part of the WBT-Master training paradigm. Any teacher selects a few components and combines them into a new course to provide a required training curriculum and system functionality. At the same time, learners can define their own personal desktops to have an individual view onto the system content and functionality;
- *Extension ability*: this is also an inherent of the WBT-Master architecture. Any new components can be developed independently and even without any relation to WBT-Master and can be combined to the system by means of the "Course" or "Desktop" metaphor;
- *Usability*: a very high level of usability is achievable because no user is supposed to work with and learn all WBT-Master functions. Only a few carefully selected functions are available to each user which makes the usage of the system very easy and intuitive.

## 4 Deployed Applications

### 4.1 Didactical concept

The screenshot shows the WBT-Master Managed Learning Environment interface for the course 'LV Betonbau WS 2005/06'. The interface is divided into several sections:

- Schwarzes Brett (Blackboard)**: A message from Karl Heinz Schlöglmann, dated 2005-11-08, 15:30 Uhr. The message discusses the arrival of EC 2 copies and provides information about speaking hours and a discussion forum.
- Lehrveranstaltungsunterlagen (Course Materials)**: A list of resources including eBooks (e.g., Betonbau, Übungsunterlagen), portals (e.g., Prüfungsdatenbank, Downloadbereich), and documents (e.g., Online Videos).
- Lehrveranstaltungsteilnehmer (Course Participants)**: A list of 19 students, each with a name, role (e.g., Student, Tutor), and contact information (e-mail, s-mail).
- Zusätzliche Lehr- und Lernhilfen (Additional Teaching and Learning Aids)**: A list of additional resources including portals (e.g., BauWiki, Interaktive Lehr- und Lernhilfen), forums (e.g., Diskussionsforum, FAQs), and thematic discussions (e.g., ARCHIV: Übungsbeispiele 04/05).

Figure 1: A particular Expert Training Course

Although learning is an active cognitive process on the part of the learner - as we mentioned in the beginning - it is also a social process and develops through conversation [Motschnig-Pitrik, 02]. Based on the assumption that interaction, participation and communication are crucial elements for viable learning communities, a learning environment has to enforce the possibility of community building. However, active engagement by the participants will only occur when they recognize that their needs are fulfilled on the one hand by the community [Preece, 00] and on the other by the course management system. From this point of view it can be mentioned, if participants' individual needs are satisfied they will be motivated and in the end they are willing to interact within the community [Preece, 02]. Combined, it should be pointed out, that the aim of the research project was to compensate the deprivation of iViSiCE – the lack of communication features. More precisely, the problem was the missing communication tools developed for a specific user group – students of Civil Engineering.

This section describes how the WBT-Master Training Objects were combined into a new eLearning course for such a specific user group like students of Civil Engineering.

#### **4.2 Main Screen**

The main innovation of WBT-Master can be seen as the flexible assembling of eLearning courses out of a number of training objects available on the server. Thus, teachers are not forced to use a predefined eLearning paradigm. On the contrary, they are meant to select appropriate the training objects and arrange them into a desired training curriculum. This approach allows teachers to build their own training environments on-the-fly, and adapt their course to their special needs.

Figure 1 shows a particular training course. The main screen is separated into four sub-areas containing references to different course components (training objects). The upper left window is meant to be used for course administration tasks such as a course description, calendar and announcements. The bottom left window lists all the course participants with references to asynchronous communication tools. Upper right window is called a course library and allows to access e-Books, documents and other Internet Resources selected for the course.

The bottom right window implements the actual course functionality. The teachers simply select the WBT-Master training tools like the FAQ list, the Thematical or Personal uploading component, the Graphical chat, the discussion forum or another tool and place references there.

It must be especially noted, that all the tools are optional and the teacher decides what particular tools are needed to avoid a cognitive overload of learners. Needless to say that the initially selected list of tools can be dynamically extended at any time allowing learners to work with more and more complex tools as they are used to primitive ones. Thus, for example Figure 1 shows an expert course with access to the whole content of the iViSiCE project. Vice Versa Figure 2 demonstrates a typical beginner course.

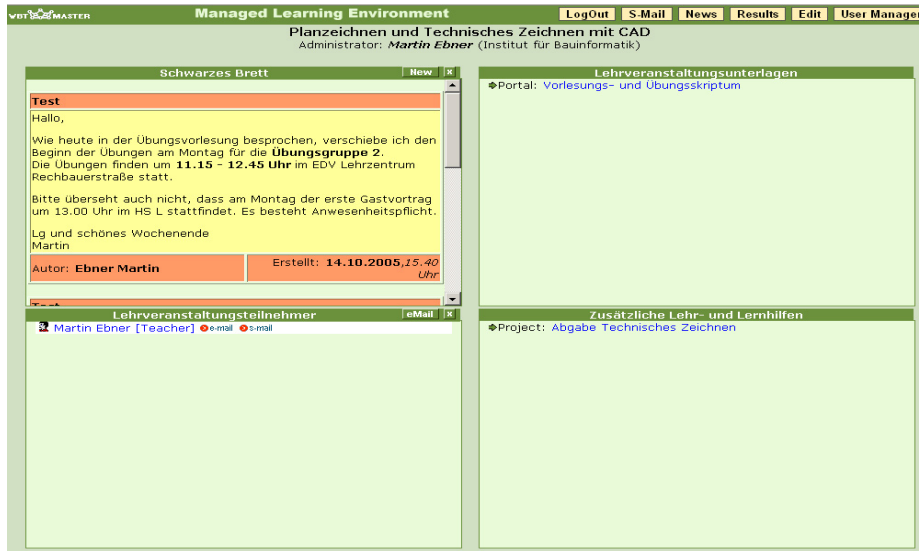


Figure 2: Novice Course

### 4.3 Discussion Forum

The first Training Object selected for the eLearning Course was a so-called Discussion Forum for the end user group.

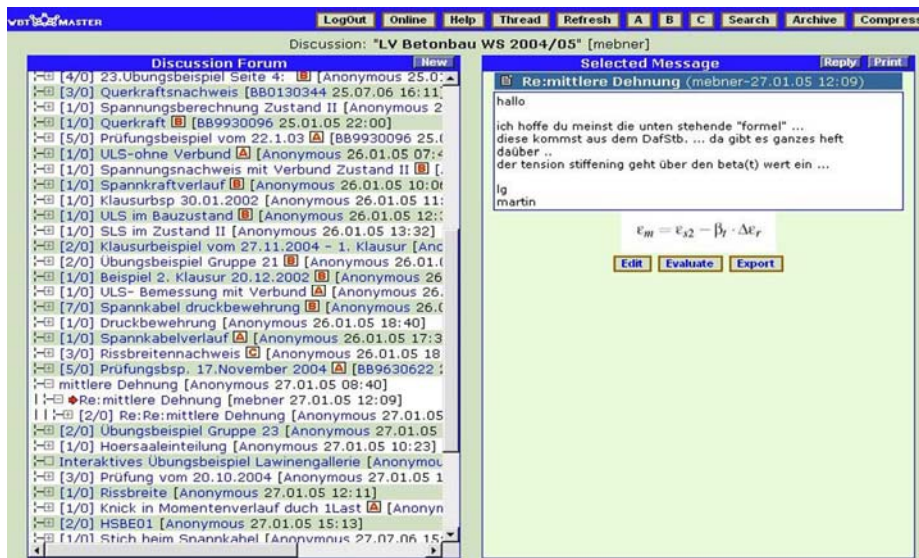


Figure 3: Discussion Forum

The following features of the Training Object were considered to be the most important ones:

- Ease of use: According to Nielsen [Nielsen, 93], the ease of use must be judged as first priority, because difficult technology defeats the real goal. The end user should never think about the technical environment, he/she has to concentrate on his/her learning goal all the time;
- A, B, C Buttons: Our recent experience shows that within a very short time the forum is very complex and difficult to manage. Especially for the kind of user group that is not involved in the online discussions for the whole time and only sometimes looks for information. With the help of these buttons this problem should be a thing of the past. Every lecturer is able to mark each contribution dependent to its pertinence to the lecture exam. This means that a contribution marked with “A” (high relevance) has to be known from each participant, “C” is equivalent to interesting but not assessment load;
- Possibility to upload pictures and formulas: As already mentioned, sometimes a question cannot be answered without an explaining sketch. From this point of view, against the general rule “no pictures in newsgroups” the possibility to upload small pictures was implemented. Furthermore an “embedded” function has been postulated so that the end user does not need to download the drawing, she/he is able to see it within the written contribution;
- Print and Thread: In the end two little features have been implemented, because students asked for them during their learning efforts. First a simple possibility to read the whole discussion thread very easily without clicking every contribution once has been developed and secondly a possibility to print the thread. So the overview of one discussion seems feasible.

Figure 3 shows a screenshot from the end products which has been used during the lecture for about four months.

#### 4.4 Graphical Chat

The next Training Object is a so-called Graphical Chat (Figure 4). In the past, a synchronous communication was only possible via chat. With such a tool virtual office hours were held by tutors and lecturers [Dimai, 03]. Due to the fact that chat communication based on written statements, linguistic differences complicated a discussion about the problems concerning the content of the lecture. The lecturers mentioned that a line would be able to replace a multi line dialog.

Concerning these requirements the expert group thought about a chat tool with a kind of whiteboard application, but within the tool.

In Figure 4 the tool is shown. On the left side there are the written statements comparable with a typical chat application. On the right side on the bottom the input box is placed and on the top the whiteboard. With the help of ordinary utilities student/lecturers are able to draw their sketches concerning their current discussion. Furthermore, it is of course also possible to upload pictures from the local disk and



discuss them. Maybe an interesting detail is also the “pointer” which helps to mark the discussed detail of an uploaded image.

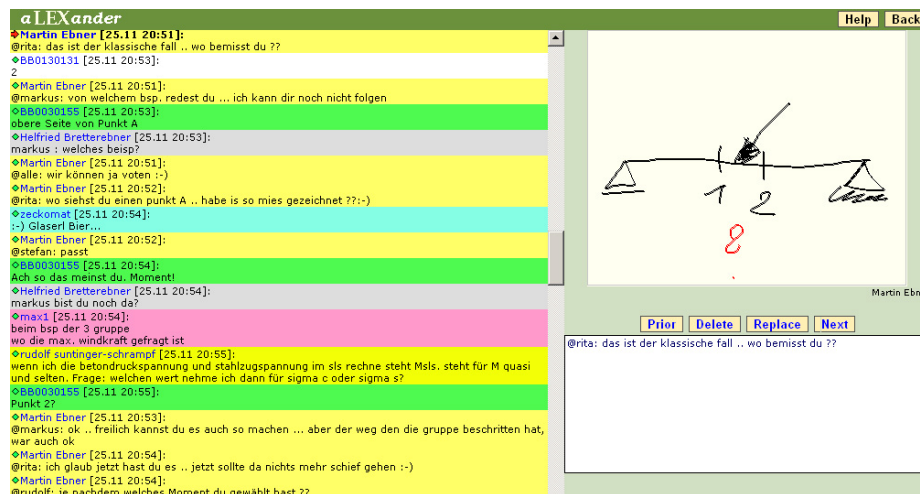


Figure 4: Graphical Chat

Certainly after the end of the virtual office hour the chat session can be saved with all the drawings and used pictures. So students who cannot participate will be able to read it at an arbitrary time.

#### 4.5 Thematic Upload

A so-called Thematic Uploading Component was supposed to help students to upload, manage and discuss their practical examples for passing the examination. Furthermore the tool assists the lecturers concerning the correct time management. This means that upload was not possible after a predefined time limit.

The didactical concept of this tool based on collaborative working and learning. According to Laurillard [Laurillard, 98] eLearning could be greatly improved by achieving the three following goals:

- Development of better ways of searching for information;
- Sharing ideas and resources amongst learners; and
- Improvement and practice of techniques of communication with others.

Figure 5 shows an example of the discussion about a solution of a framework model in structural concrete. On the right hand side not only the example is presented but also the uploaded solutions of the learners. In the left column there is the associated discussion forum and the selected contribution.

Figure 5: Thematical Upload

#### 4.6 FAQs

After about one month using the described applications the authors recognized that some postings in the discussion forums were principally nearly the same. Although the lecturers suggested the learners to use the available search function instead of a new posting the behaviour of the end user did not change fundamentally. Maybe these problems caused by the troublesome looking for used keywords in an arbitrary posting or the unclear description of the problem in the head line.

Figure 6: FAQs

In order to tackle the problem, the course was dynamically extended with a so-called FAQ Training Component. This component allows lecturers to export questions from the forum and arrange them into an easily browsable FAQ taxonomy.

Figure 6 shows the application – on the left there are several topics concerning the contents of the lecture, on the right side questions and the answers are listed.

## 5 Evaluation

A number of anonymous online evaluations were carried out to assess the overall success of the project. The most important results are provided below (Table 1).

*Table 1: Result of the evaluation*

<b>Question</b>	<b>Average</b>
1) Does the eLearning course increase quality of the study? (yes, indeed = 1; not at all =5)	2.0
2) Should this approach be extended to other courses? (yes, indeed = 1; not at all = 5)	2.06
3) Does the eLearning course support my personal learning process? (yes, a lot = 1; not at all = 5)	2.59

### 5.1 Analyses of the evaluation results

Results of evaluation were considered as positive in respect to questions 1 and 2, and as neutral in answering the question 3. Thus, the table shows that the majority of students do accept the eLearning paradigm and tools. At the same time, there is still a big area for innovations in personalization of the system as shown by the question 3.

### 5.2 Discussion Forum

The online evaluation questionnaire was answered by 23 students and the result is shown in Table 2.

Table 2: Result of the online evaluation of the Discussion forum

Question				Average
1) The discussion forum supported my learning process a lot (a lot = 1; not at all =5)				2.0
2) I think the possibility of embedded pictures is useful (a lot = 1; not at all = 5)				1.2
3) The discussion forum follows the ease of use paradigm? (a lot = 1; not at all = 5)				1.9
4) I used the function of the A, B, C Buttons? (a lot = 1; not at all = 5 )				1.7
5) Which features did you ever use?				
Print	= 20%	Thread	= 36%	Search = 7%
				A,B,C = 68%

### 5.3 Graphical Chat

At the end of the lecture program a questionnaire about the whole eLearning activities was carried out. 25 of 52 students mentioned that they have participated on a virtual office hour at least once (Table 3).

Table 3: Results of the questionnaire concerning the Graphical Chat

Question		Average
1) I think the durability of the office hour is ... (too long = 1; fitting =2; too short=3)		1.96
2) I think the possibility of drawing is useful (a lot = 1; not at all = 5)		2.52

## 6 Discussion and Conclusion

As the results of the evaluation showed, the taken measures seem to be successful, especially the high acceptance of the A, B, C functionality. Two-thirds of the forum users used it for their browsing through the contributions and they rated it with an average of 1.7 (Table 2). Due to the fact that online forums are not readable within a very short time because of the horrible mess of contributions this little feature helped to make a difference between relevant and not absolutely necessary written messages.

Further, contrary to the general rules, the possibility to embed some helpful drawings in the forum has also been used several times. But we have to emphasize, that of course the used files have to be very small to keep the traffic and the download rate low.

The authors noticed that the drawing functionality within the graphical chat is rated not as high as the discussion forum. Two reasons could account for this - first the lecturers recognized that the students themselves realized very late that they are able

to draw something and second there is the problem of creating a technical drawing with the mouse as input device. The lecturers used a graphical tablet with a pen.

It should be noted that *all* the students reported their positive experience with this system. The project team is going to expand this approach for other courses. From our point of view, the best way to improve the learning process is to involve the lecturers during the development of an application and to modify it to their specific needs. “Regarding the user requirements” will be a main paradigm for our next steps towards an eLearning support for the whole University.

According to Ben Shneiderman [Shneiderman, 02] “The old computing is about what computers can do; The new computing is about what people can do” we like to rephrase it to “The old eLearning is what course management system can do; The new eLearning paradigm is about what learners can do”. This means that we have to think about the specific needs of each target group and adopt the existing tools to their requirements.

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