

How Web2 enhance knowledge construction in civil engineering

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Summary

At Graz University of Technology (TU Graz) lots of experience using multimedia or internet based applications in higher education has been gathered. Especially in the field of civil engineering we can refer to a seven year long practical employment.

During the very first e-Learning boom at universities in Austria in 2001 some projects in the field of civil engineering have been started in order to investigate the possibilities of web-based education.

Nowadays a radical change of the Web, often called Web 2.0, offers possibilities, which can change the e-Education dramatically. The use of Wikis and Weblogs lead to a more collaborative teaching and learning process. Podcasts, in the same way as web based software helps to support the learner of today in a much more efficient way as in the years before.

This paper will discuss how modern technologies can be used in the field of Civil Engineering Education and will show a lot of practical examples of today's effort in this field at TU Graz. The authors conclude that e-Education will play a very important role in the future of higher education. Bearing in mind that learners of today are the working society of tomorrow this change leads to arbitrarily new situations. Has industry to prepare for a new kind of generation?

Introduction

Mark Prensky [24] wrote, "Our students have changed radically. Today's students are no longer the people our educational system was designed to teach". Considering the radical changes of today often summarized as Web 2.0 or eLearning 2.0 is there really such a major turning point? Are learners who are reaching the university comparable to those of some years ago? Currently numerous of those questions are discussed within the university, but only little research has been done. Especially if we take a look to each technical discipline, what does it mean if learners and Internet technologies are changing radically?

As the so called Web 2.0 hype is cooling down, the discipline is becoming more mature and previously skeptical people are now integrating the provided tools into their daily workflow. Accordingly we can expect the technology to grow more and more into our lives. School kids, teenagers are very fast at adapting to new habits and likely to try out a lot of different approaches. In the

field of eLearning some more issues come into question: How settled are these new technologies among people that come to study at our university? Do they only consume or do they contribute their own work and ideas, therefore knowing how to handle blogs, wikis and similar platforms? How much can they benefit from working with these? Or the other way round: how much do we impede them by not offering new ways of learning and community work?

Due to the fact that the Internet pervades our daily life and availability is still increasing, maybe the whole university teaching and learning process has to be rethought. Our daily life is increasingly taking place online, for example banking activities, booking, reading news and so on, and will lead to a new way of use. The growing bandwidth accommodates the demand for watching TV and movies online or send audio files as podcasts to recipients all over the world. This changes our life and our behaviour tremendously.

The availability of new mobile technologies such as mobile phones or PDAs allows for the use of these devices [30] not only in business or private life but also for learning settings [20]. Technology has impacts on learning settings and learning styles [20]. If people are becoming increasingly mobile, why should they not learn mobile? Is this the challenge of the future? Why should we not assimilate informal communication, distribution and consumption structures for the learning processes?

As a matter of fact we can constitute that learning and all further processes concerning the educational system are changing. Ally [1] mentioned: „At the same time, today’s and tomorrow’s learners will be nomadic and continuously on the move. As learners move from one location to the next, they must be able to use the infrastructure in the different locations to access learning materials. Hence, learning materials must be designed for easy access by the nomadic learners using mobile technology regardless of where they are located and which network infrastructure they are using to access information“.

Obviously there are many facts pointing to a different future in learning behavior, but how is the daily situation really at the university? Some research work in the last years tried to identify the differences between teenagers, so called “net generation” [23] or “digital natives” [24] and their lecturers.

e-Education or Learning with Internet technologies

First, before investigating the use of new technologies, we have to take a look at the fundamental basis of education itself. Teaching and learning are both social processes and are happening between people: teachers are interacting with learners, learners are interacting with other learners and since few years there is a new kind of interaction – between learners and computers. The possibility of interaction is absolutely necessary because learning as a highly social process proceeds through and bases on conversation [5] [19]. Learning needs immediate feedback in the same way as user-dependent reactions. According to Vygotsky

[27], the relationship between interaction and learning is fundamental and can be summarized in three sentences:

- Learners' achievement levels depend 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 first assumption is that learners must be actively engaged in collaborative work maybe with the help of computer technologies. Didactical settings and scenarios should be designed in a way that engagement instead of passive consummation will be possible.

A further important aspect for learning purposes is motivation. By increasing the motivation learners can be engaged or attention to the learning material can be maintained for a longer period of time. Elton [15] also mentioned that increasing motivation is an essential factor for successful learning. "Make student feel more confident that they will be able to pass the examination, the grading" is claimed by him. In other words high commitment to the goals of a lecture is only then possible, when the students are highly motivated.

Due to these facts it must be pointed out that new technologies could be very powerful if interaction, collaboration and motivation are supported. Initially multimedia and subsequently the World Wide Web in general seem to provide possibilities to teach and learn in a complete different way. The often quoted expression A³ (anytime, anywhere and anybody) in the very first time of elearning lead to a big hype for technology enhanced teaching.

Nowadays Web 2.0 is reaching the lecture rooms and invites users to actively participate. "User generated content" or "user is the content" stands for a new online generation. Wikis, Weblogs, Podcast or similar applications allow easy online publication. Of course also teaching and learning processes are affected and shift to a more learner-driven behaviour can be expected. From a research point of view a movement from eLearning 1.0 to eLearning 2.0 is occurring.

eLearning 2.0

e-Learning 2.0, first coined from Stephen Downes [6], is a synonym for the use of Web 2.0 technologies in education, but is mostly not viewed from a technical point of view rather but from a social one. The technologies themselves are not really new – Wikis for example were invented by Howard Cunningham in 1995 [4] – so why is now such a boom possible, what is the "changing" term?

Three components should be taken in account:

- Device: Nowadays the access to the Internet is not only restricted to a Personal Computer with a slow cable modem. The typical learner or teacher in the area of universities in Western Europe uses his Laptop,

PDA or even his mobil phone and WLAN to connect to the Internet. It must be pointed out that the independence of the device is definitely on another stage as for example ten years ago.

- **Accessibility:** Access to the internet is not only possible for students, but also with high connection speed which allows for working online. Data transfer takes not hours; videos can be directly consumed online and emails are a usual part of daily life.
- **Human Factor / Usability:** The acceptance of the Internet is widely accepted and leads to a real new human behaviour. Nowadays nobody is wondering why lecture materials are available only online or lecturers are sending emails instead of making announcements. Further the usability of internet applications has dramatically changed. Some years ago special skills and knowledge were necessary to contribute to internet pages. Only few programmers or web designer had the opportunity to provide content. Web 2.0 is the beginning of active user participation. Usability, Internet technologies and also the users themselves have reached a level which allows a new exposure with online content.

The Web is changing dramatically – an enormous growth rate, an increase in the number of technologies and applications. On the other side there is the well established and researched science of education. In other words the gap between traditional science of education and emerging technologies of e-Learning is growing rapidly.

Finally also the learners themselves are changing and it should be summarized with a quotation [26]: “... there seems to be a divergence between the learning content producers, and the content users. While producers are trying to force everything into closed systems, the users want to use open systems. (...) We can already see a convergence between these new open media tools and constructivist learning: all three requires the users to construct their own content.”

From the very first beginning to the use of Web 2.0 technologies and beyond

The TU Graz has a long tradition in e-Learning research. Extensive experience in design, implementation and the operation of large online hypertext services for fairly large user communities has been gained [29]. Especially the Institute for Information Systems and Computer Media (formerly Institute for Information Processing and Computer Supported New Media) where Hyper-G was conceived, has managed to actively contribute to theoretical research as well as practical examples. Hyper-G, Hyperwave or currently WBT Master are only a short excerpt of developed e-Learning systems [22].

Especially in cooperation with the educational field of civil engineering the project iViSiCE was established in 2001. The aim was to investigate the possibilities of multimedia use in the field of structural concrete. Some research papers examined how the use of animations, interactive learning objects, communication tools and games can expand the traditional learning and teaching scenarios in a meaningful way [6, 7, 8, 9, 10].

In the same way a special kind of e-Learning software for interactive structural analysis, the program EasyStatics [2] is in use at the Institute for Building Informatics.

Animations and Interactive Learning Objects

Since 2001 the Institute of Structural Concrete and subsequently the Institute of Building Informatics has focussed on the use of Web technologies to enhance the education in civil engineering especially structural engineering.

Therefore the project iViSiCE (interactive ViSualisation in Civil Engineering) was founded. It aimed to improve lecturing and learning by so-called new media. 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 visualisations. Bearing this in mind the project defined 3 crucial aspects:

- Communication
- Animation
- Interaction

In the first phase of the project lots of animations and simulations were created to describe complex engineering problems.

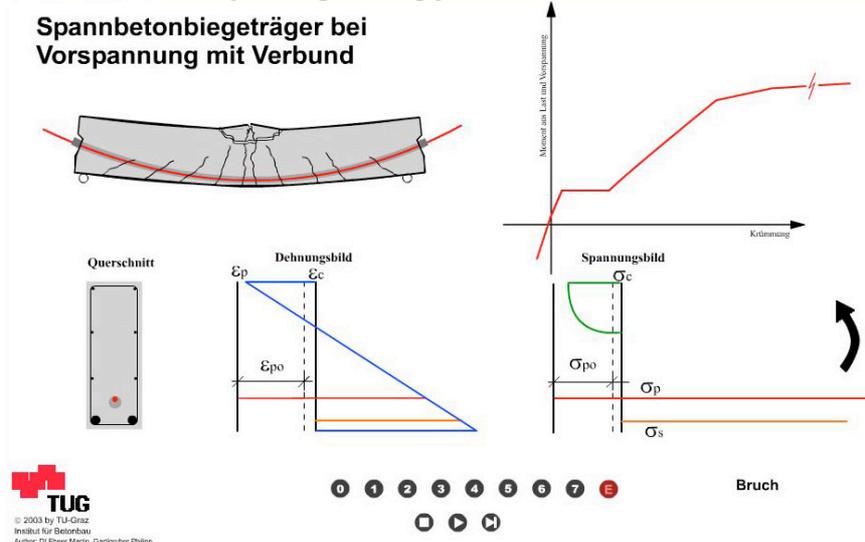


Fig. 1 Prestressed concrete beam

Fig. 1 shows a predefined concrete beam. Students can see at once the relationship between stress and strain as well as the bearing load. Furthermore a diagram displays the coherence between bending moment and curvature. Nowadays these animations are being taught in traditional lecture rooms in a typical face-to-face situation. After the lecture students can run the application at home on their own by using usual Internet connections and standard Web browsers.

Besides different communication strategies, e.g. the use of discussion forums, chats etc. the next step of research focused on the learning theory defined first by John Dewey [5] “Learning by doing”. Thus learners should be actively involved and have to play an active role. Consequently so-called Interactive Learning Objects were created on the base of didactical strategies as instructional design according to Gagne [16]. It must be pointed out that the crucial factor of successful Learning Objects is to address to one specific learning problem that shall be solved interactively.

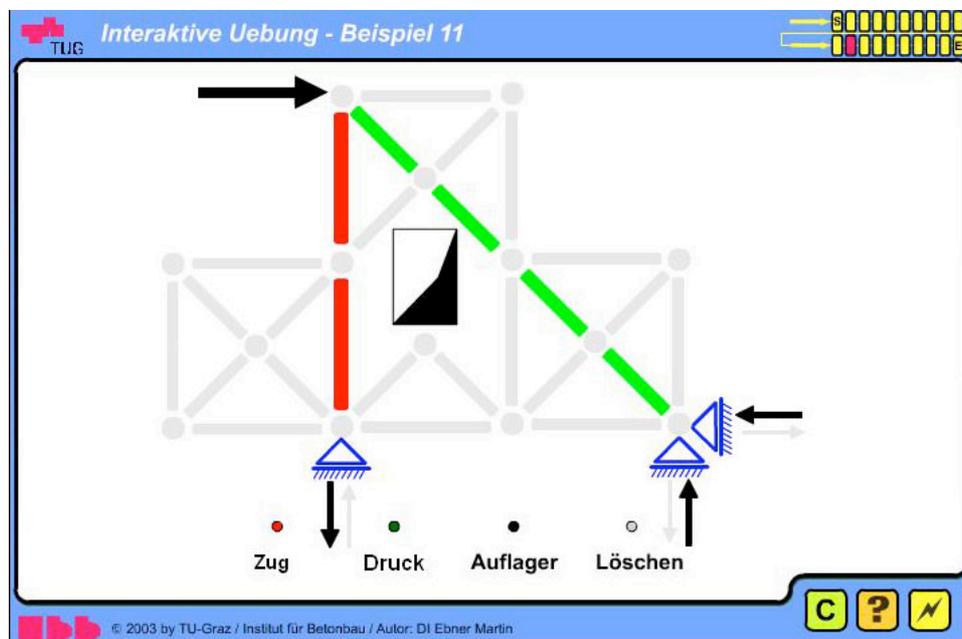


Fig. 2 Interactive Learning Object – Strut and Tie model

Fig 2 shows an Interactive Learning Object that helps learners to understand the flow of forces in thin structural concrete plates and panes. Students have to colour the provided truss green or red depending on whether the reactive force is tension or pressure.

Game based Learning in Civil Engineering

A further activity of the project was to create a more motivating learning approach. Due to the fact that learning often is felt to be hard work for the individual learner even learning with Interactive Learning Objects was not attractive enough apart from first enthusiastic attempts. Furthermore it is a fact that the learning effect is much higher if it happens within an emotional and motivated context, such as playing a game [3] [18]. Due to this fact and following the buzz-word edutainment the main research question was if it is possible to create a game that helps to increase the motivation for learning civil engineering.

Consequently a web based Flash game was created, called Internal Force Master. The idea was quite simple: The learner got a static determined system and three possibilities of correct solutions (bending moment, shear or axial force). Within a short time frame the right solution had to be chosen to reach the next step respectively level.

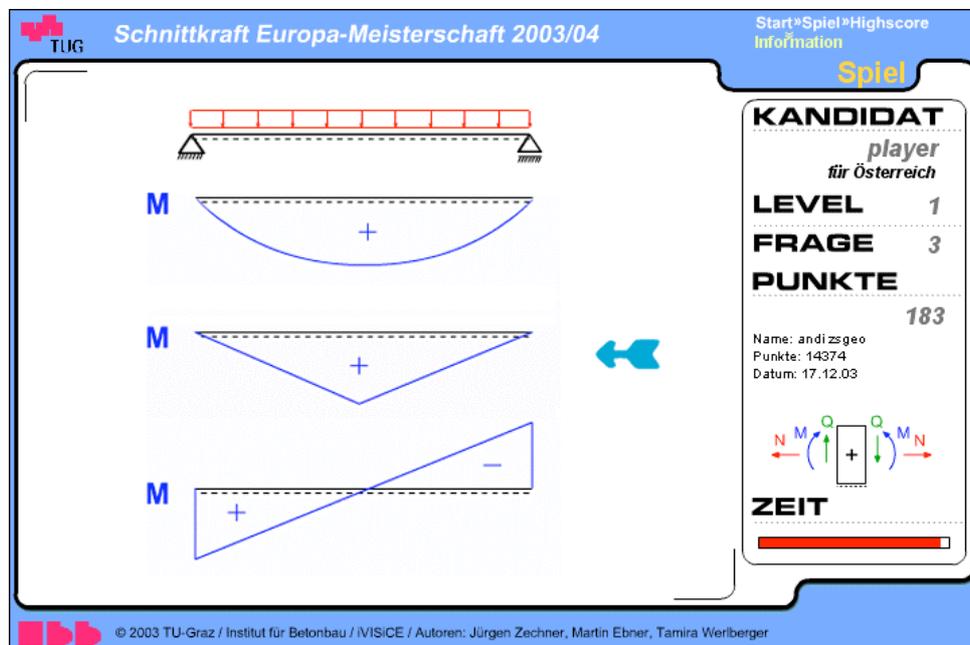


Fig. 3 Game based Learning –Internal Force master

Fig. 3 shows the successfully used main screen of the game– within 3 months the game had been started over 23000 times. An evaluation including a pre- and post-test pointed out that the intended incidental learning occurred. The game lead at least to the same learning result as learning by traditional methods, but with one additional factor called “fun” [11].

Bauwiki – the first step towards Web 2.0 technologies

In the beginning of 2006 the Institute for Building Informatics introduced a Wiki-system to their students for the first time. Similar to the best known and most famous Wiki-system, Wikipedia®, students wrote articles online and collaborated with each other. Concerning the power of a Wiki-system learners should be able to create, edit, revise or simply link articles just on demand.

Today the so called “Baulexikon” (<http://bauwiki.tugraz.at>) holds a hundred articles about special civil engineering topics [12], all well written by students of the first semester. The didactical effort of the “Baulexikon” is that learners on the one side learn to use modern technologies (often it is the first contact with markup languages) and on the other side experience the power of collaboration in the same way as the simplicity of the tool.

A further Wiki-project concerned the lecture of Compute Science II [11]. It aimed to provide students a framework for learning Visual Basic for Applications (VBA). Learners themselves created the articles, exchanged and revised them; lecturers only supervised. In this particular case a whole electronically resource was created by learners themselves within a very short time. Once the Wiki had been finished it was used within practical examinations during the whole semester.

Podcasts

The term “Podcast” is a mash of Apple’s mp3 player “iPod” and the word “broadcast”. A definition of “Podcast” as Wikipedia explains it “A podcast is a media file that is distributed by subscription (...) over the Internet using syndication feeds, for playback on mobile devices and personal computers.”

In other words only the combination of a media file with the RSS technology, where users are able to subscribe can be named as Podcast. The use of Podcasts in Higher Education is mainly a recording of the entire lecturers – audio (the voice of the lecturer) and video (capturing the computer screen of the lecturer). This file is adapted and distributed online in four different formats: .avi (all operating systems), .mp3 (only audio), .swf (navigatable through all slides) and .m4v (the iPod file). With these file types nearly all devices can be supported. Fig. 4 shows a screenshot of a Podcast of the lecture Computer Science I.

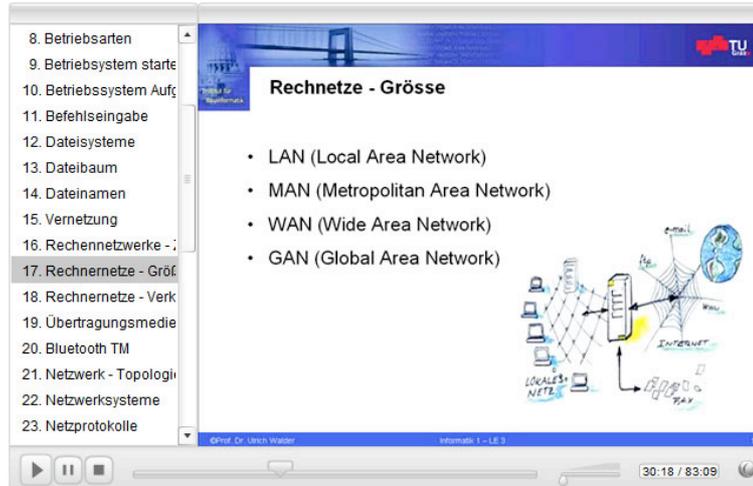


Fig. 4 Podcast of lecture “Computer Science 1”

After the lecture interviews and a test took place to get feedback about the use of the podcasts. First we addressed to the question “Do you use the podcasts for your learning?”.

Participants (N)	one	More than one	All	Never
55	18%	18%	0%	64%

Tab. 1 Question: “Do you use the podcasts for your learning?”

Participants (N)	No time or technical problems	I do not know about the possibility	Not related to the examination	Further
44	25%	37%	30%	8%

Tab. 2 Question: “Why did you never used a podcast?”

Tab. 1 shows that about one-third of the students used the podcasts for learning purposes. From our point of view a very amazing result, concerning that this method was used for the very first time. Tab. 2 should find out, why learners do not use the podcasts. It was interesting to notice that nearly nobody mentioned that the captured lectures are unusable for learning. The main problems are technical ones; students do not know that there are podcasts offered or that the didactical scenario is not appropriate.

It can be summarized that podcasts are a useful tool, if there is a didactical setting and clear information on how to use them and where to them get from.

Lecturing with touch-screen technologies

In consequence of the podcast activities that caught on strongly, the didactical concept was enhanced. Podcast as well as PowerPoint in general lack of less interactivity. Lecturers often are not able to annotate slides or to provide formulas as well as necessary sketches in order to explain the content more detailed. Especially in the field of civil engineering this fact seems to be crucial because drawings are essential.

At TU Graz, respectively the department Social Learning began in 2006 to introduce the use of Tablet PCs for teaching. By combining the advantages of a Tablet PC with the possibility of podcasting lecturers of mechanical or mathematical lectures were recorded. Nowadays student of a variety of fields of study receive media files automatically via RSS after the lecture was recorded.

It must be pointed out that learners as well as teachers love this service for several reasons – for example: It enhances the learning process (students can hear as often they want to any explanation) and it reduces some administration effort (instead of asking the same question again and again, teachers refer to specific sequences).

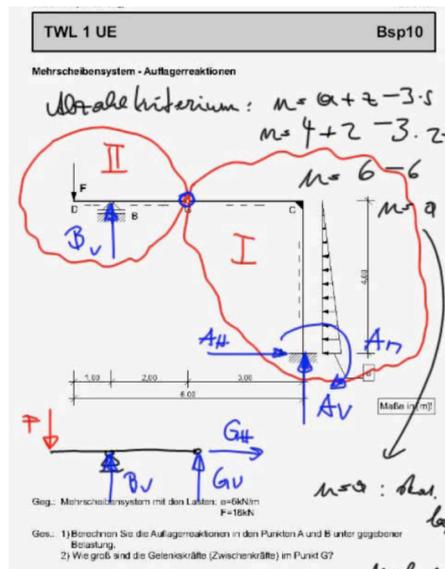


Fig. 5 Screenshot of lecture “mechanics for architecture”

Fig. 5 shows a screenshot of the lecture “mechanics for architecture”. It must be noted that the learners got the predefined sketches via handouts beforehand.

Social Bookmarking

Since October 2006 the TU Graz is running a so called Blogosphere. Based on the open-source software ELGG (<http://elgg.org>) TU Graz LearnLand was established to support the whole university with so called Weblogs. Weblogs can be described as “frequently updated websites consisting of data entries arranged in reverse chronological order” [28][25]. Each member of the university (lecturer and students) can easily create a Weblog and publish content on the Internet. Currently a lot of studies and research projects are running to determine the use of Weblogs for Education. As an example it can be pointed out, that students were blogging for a whole semester during the lecture “Social Aspects of information technologies” [14]

An extension of the platform is the possibility to save and share bookmarks online. Comparable to the famous social bookmarking tools del.icio.us (<http://del.icio.us/>) and Mr. Wong (<http://www.mister-wong.de/>) TU Graz LearnLand offers all participants a possibility to store bookmarks online.

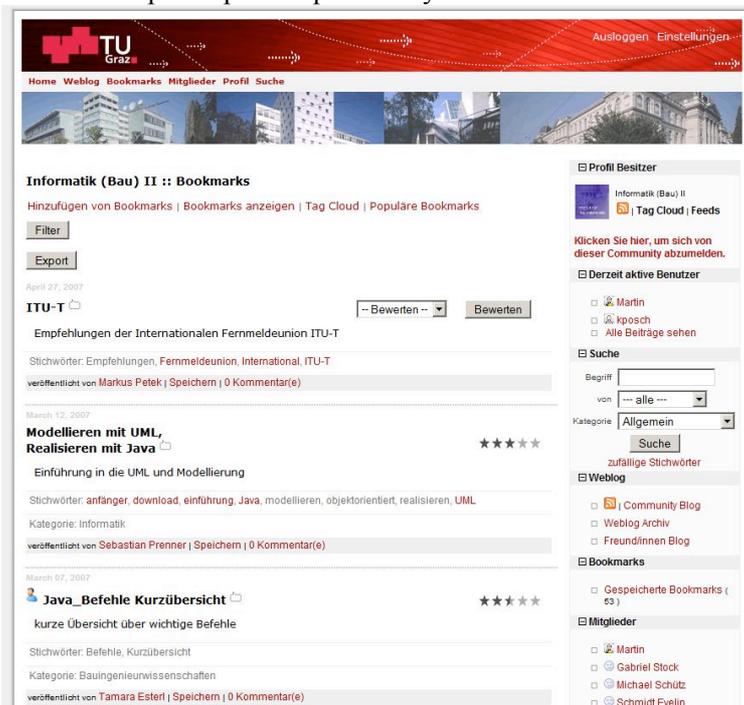


Fig. 6 Bookmark Sharing within the lecture “Computer science 2”

This feature has been used for the lecture “Computer Science 2” for students of civil engineering. The topic of the course is about software engineering and

programming with Java and of course there are many internet resources – source codes, examples, books, forums etc. The idea was not that each student should search for these resources on his/her own since this would be too time consuming. According to the philosophy of Web 2.0 the community should work and each participant earns the benefit. To summarize it very shortly, each student as a part of the community has to provide at least one resource (a bookmark) concerning the lecture topic.

The amazing result is shown in Fig.6: Within three hours 52 bookmarks were provided and the quality of the Hyperlinks was of high value - for all, lecturers and students.

M-Learning and Geotagging

A very recent research activity is to use the power of geotagging and Web 2.0 to enhance the education by bringing the work-on-site back to the lecture room and to keep on collaboration.

Geotagging describes the tagging of mainly pictures with global coordinates. By the use of a GPS-tracker or even a mobile phone with GPS-receiver it becomes easily to add the exact geographical position to a picture just taken. In combination with existing maps (e.g. Microsoft Virtual Earth or Google Maps) the visualisations of the located place become realizable.

The TU Graz started two projects mainly basing on two ideas:

1. Global Coordinates according to pictures enhance information arbitrarily especially in the field of civil engineering
2. Collaboration should help to improve the learning outcome

According to these assumptions a so-called Geowiki is developed, that combines the power of a Wiki-system on collaboration and of geotagged pictures. It allows uploading such pictures and shows the position automatically on an embedded Google Map.

For example learners take pictures on a field-trip or on-site and upload their pictures to the Wiki-system. Back in the lecture room pictures and places can be easily described collaboratively. Fig. 7 shows an example of one of the first research studies in this area.

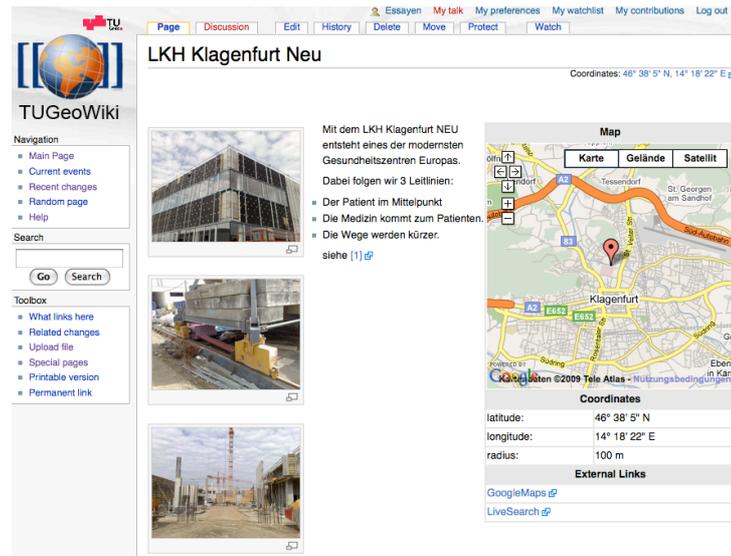


Fig. 7 Screenshot of the GeoWiki

Knowledge transfer for industry

Bearing in mind that the current possibilities of Web 2.0 and e-Learning 2.0 are only the beginning of digital media in learning, what will the future of teaching and learning look like?

The first statement of this article was that end-user devices would be completely integrated in our daily-life. Mark Weiser [24] called this ubiquitous computing, because computers, mobile phones, PDAs and comparable devices are with us to support us in our daily work. From this perspective it seems very clear that learners of tomorrow will not talk about e-Learning anymore, because information, learning materials, discussions, podcasts etc. will be online anyway. This population will never assume that they cannot get all relevant information via the Web – it will be part of their daily-life. This leads to the assumption that the term e-Learning becomes dispensable; furthermore maybe it will be replaced by the term u-Learning (ubiquitous Learning).

This change of teaching and learning behaviours also lead to changes of how teachers and learners deal with technology and media in future. Within a very short time people were able to exchange different kind of media, edit webpages and write on different platforms. Digital literacy, defined as the ability to understand, evaluate and integrate information in a variety of formats delivered by computer [17], has become one of the core competencies of today. Because of dramatically increasing information in the Web as well as dramatically increasing number of different devices a future engineer must be knowledgeable about

modern digital possibilities. Different organisations, for example the Association for Progressive Communication, are discussing the problems of digital divide and digital gap that describes the difference between people having no access to such information technologies and those that have. In addition the arguments must be enhanced by the questions – if we have access to the biggest data storage ever, can we use it for our own purposes?

Furthermore a very important aspect in getting such skills is that learning will not end by getting a degree. LifeLongLearning is one of the key roles of the European Union to ensure the future of our knowledge society. However it is obviously that LifeLongLearning and digital technology needs each other. Learning on demand and just in time at anyplace will not be possible if there are no appropriate technologies and possibilities.

At last it must be pointed that the participation in so-called social communities as well as the use of collaborative software improves new growing and necessary competencies such as informal learning or working in groups. In a global world communication and sharing relevant information between different cultures will become common. Such tools can help to interact and allow discussing worldwide.

Summary

Without any doubt man is currently turning from media consumer to producer. This for sure leads to a new kind of dealing with information. Since education will be strongly influenced by new Web technologies it is absolutely necessary to investigate how such technologies can be used in special didactical settings at universities [31]. Learners of tomorrow will use technologies of tomorrow and the university has to prepare itself for and adapt to it.

Furthermore we have to be aware that human's nature does not change but human's behavior does. New technology will not make us more social but it influences strongly our behavior. In the same way industries of the future will install different web-based tools and of course assume that everyone will be able to use it, the influence of digital technology will increase without any doubt and the use of digital possibilities will change humanity sustained.

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