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Shift from teaching to learning with Web 2.0

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Abstract: The shift from teaching to learning means reversing the traditional teacher-centered understanding of learning, putting students at the center of the learning process and letting them participate in the evaluation of their learning. It is a shift from the teacher, who possesses and communicates knowledge with a particular aim, to the students, who acquire the knowledge they need to solve a problem with the help of the teacher. This paper presents a socio-technical community approach, which supports the shift from teaching to learning, and a first prototypical realization of a new kind of computer and Internet based teaching and learning systems at a Department of Computer Science in Germany. Numerous students (approx. 80-400 per lecture) participated in these lectures. Based on our empirical experience from 2002 until today, we present a good practice that combines face-to-face meetings and online discussions.

Keywords

CS Curricula, Concept and tools for e-learning, Community-based learning, Learning paradigm, Supporting learning processes

1. Introduction

The shift from teaching to learning is a vital point of discussion in higher education [13]. This paradigm means a shift from teacher-centered to student-centered teaching and learning concepts. Student-centered learning means reversing the traditional teacher-centered understanding of learning, putting students at the center of the learning process and letting them participate in the evaluation of their learning. It is a shift from the teacher, who possesses and communicates knowledge with a particular aim, to the students, who acquire the knowledge they need to solve a problem with the help of the teacher.

It is important to note that a student-centered learning approach also means that students need to be better qualified in managing their own learning process and therefore need more information about how their curriculum is structured. Not just pure professional information must be presented but also administrative information. The teacher should be accepted as a moderator of the learning process thanks to her/his professional expertise, not her/his formal status as a lecturer. This is not as simple as it seems because teachers lose their native rights, which they were used to have by their role alone.

Traditional computer-based learning concepts are teacher-centered, e.g. vocabulary training

software. More up-to-date learning systems are more flexible, adaptable to different existing levels of knowledge and learning strategies, but are usually controlled by the teacher as well. Both do not implement concepts that embed the whole learning process into the given curriculum and empower the students to manage their own learning. These didactic concepts follow the same philosophy as the techniques used in the early days of the world wide web.

In contrast, Web 2.0., a buzzword created by O'Reilly in 2003 [9], emphasizes social software applications that are heavily reliant on human interaction, collaboration and social networking. The role of the user is changing from reader to author, from con*sumer* to *pro*ducer and both: "prosumer". Web 1.0 is still 'information download', whereas Web 2.0 is evolving into communication about information, and cooperation. Therefore, Web 2.0 also stands for Internet-based human interaction.

Current investigations of web-based communication show how groups can be adequately supported. Forte and Bruckman [6] as well as Wasko and Faraj [11] have investigated persons' motivations for contributing to Wikipedia, and its social change.

Web 2.0 works very well in the public and private sector. In contrast, it is just beginning to be used in universities. How can we use Web 2.0 or other technologies for supporting a shift to student-centered learning in Informatics education? How can we use these learning technologies to improve students' learning and the outcomes of our academic programs? How can we improve e-learning in student-centered settings?

This paper presents a socio-technical community approach, which supports the shift from teaching to learning, and a first prototypical realization of a new kind of computer and Internet based teaching and learning systems. Numerous students (approx. 80-400 per lecture) participated in these lectures. Based on our empirical experience from 2002 until today, we present a good practice that combines face-to-face meetings and online discussions.

2. Initial Situation

In 2001, the Department of Computer Science (at the Dortmund University of Technology, in Germany) had approximately 2,000 students. From 1996 to 2001, many students had not graduated with Computer Science degrees, according to an internal statistical report published in 2001. This report showed that many students ended their Computer Science courses after three or four semesters without a degree[1] or even moved to another university; others did not take the written examinations. However, we did not know exactly why the students were failing, and so, we wanted to find out why students were dropping their Computer Science studies.

We assumed that the problem was not only related to the content of the courses but also to students' management of their studies. So, the primary question was: how do German Computer Science students organize their studies at a university? Do they have enough information, and the right information, about how to organize their studies successfully?[2]

A first observation was that it is not enough for students to be experts in their subject, but

1 The suggested study time for an Computer Science degree in Germany is nine semesters (4-5 years). The majority of students take 12-14 semesters to complete their degree (6-7 years).

2 German students often have a high degree of freedom: the decision in which semester to attend lectures or seminars or even in which semester to take examinations is left to the discretion of each student.

they also need to be experts in managing their lives as students professionally. As a consequence, the faculty not only has to provide content, which belongs to the curriculum, but also has to provide all available information that enables students to manage their learning process. It is less relevant how much information is provided by the faculty, but it must be the right information.

A second observation was that learning and coordinating the learning process often take place not at the university but at home, whereas teaching is usually located at the university. So we saw the need for a system that permits a continuation of the learning process over distances. However, it is necessary to understand the status quo of the learning processes first, before integrating adequate technical applications.

A third observation was that traditional status groups and organizational structures are not very relevant for the learning process, because roles in a learning process are not identical to roles in organizational structures.

3. A new practice for teaching and learning

Starting from the problem of self-organization and study management, we launched the WIS project[3] in 2001. The aim was on the one hand to find out what the barriers to studying were, and on the other hand to establish what factors led to success for students of Computer Science. Finally, we wanted to give the results back to the students in order to initiate a discussion about these issues. The primary purpose of the empirical procedure was to help students build their own online community that would be concerned with study management.

In addition to the practical purposes, we used the project to study people's behavior as well as emerging changes of social structure and social roles in the online community. The project was based on an exploratory research method that includes ethnographic observations, qualitative interviews and questionnaires. The research design was triggered by an action research process [1].

The empirical exploratory method was essential, since we did not have sufficient hypotheses to explain why the students dropped their studies. From interviews conducted in 2001, it was clear to us that a software system was needed that was tailored specifically to the needs of the social system it was meant to foster. To develop this special software system, we tried to amalgamate the software-technological approach of the spiral model according to Boehm [4] with the phase model for communities according to Wenger et al. [12], as described in Jahnke, Mattick, Hermann [7]. The technical product could be similar to Blackboard or other VLE; however, an essential difference is that InPUD only contains a small subset of their functionality. Our approach focuses on students' learning processes; Blackboard is rather teacher-oriented.

3.1 Steps of the implementation process

Our empirical procedure included the following four phases of action research:
A) Identifying the problem(s): In semi-structured interviews, we looked at different students' problems with study management. In face-to-face interviews, held between 2001 and 2002

3 WIS is an abbreviation for the project 'Development of Computer Science' at the University of Dortmund (Prof. Dr. Thomas Herrmann). It was promoted by the state of North Rhine-Westphalia (Germany) from 2001-2004.

with an open-ended interview guide, we talked to 14 people (8 students and 6 professors/lecturers). The various aspects of how students manage their studies were summarized in different areas:

- Students knew the importance of attending lectures and learning groups even when they did not attend[4];
- The city of residence was often not the same as the place where the students studied (many students traveled to the university by car or bus every day);
- The majority of students took on jobs to fund their studies; consequently they had less time to attend courses;
- New students at German universities needed a high degree of self-organization, but they had not learned it (and it had not been taught).
- There was a significant amount of information about Computer Science courses available; however there was no single portal that organized this information. As a result, students were forced to search through a jungle of information to find a suitable course.
- A large number of students said that they had become disoriented during the regular nine semesters (4-5 years), becoming unsure of when to attend which lectures and seminars and when to register for and sit specific examinations.

Based on these practical problems, a standardized questionnaire was sent out to the Computer Science students at the Technical University of Dortmund. 384 completed questionnaires were returned. This represented a total of about 20 percent of all Computer Science students enrolled in the bachelor courses. The results confirmed the following thesis: The majority of students knew in theory how to organize themselves for a successful Computer Science course, but they did not practise it.

B) Creating an information portal: The interview results from phase A prompted us to create an Internet-based information portal that would offer an overview of each lecture, seminar and course each semester, and a graphical plan of the first four semesters (corresponding to a bachelor course). We decided to use computer support for two reasons: (a) due to the large number of students who would be involved, and (b) in order to document the process for the next generation of students. Additionally, the portal would enable information from the study-management advisors and other university roles to be shared. In May 2002, the first prototype of the community system called "InPUD" (Informatics Portal University of Dortmund) was launched. The software system was revised twice and adapted to the changing technological standards on the web, to make it better maintainable and to be able to enrich it with new features that users ask for. The current version is realized by using a standard content management system, enriched with some domain specific components, programmed manually[5]. It is thus increasingly becoming a real Web 2.0 application.

The implementation of the portal leads to great difficulties, not with the students, but with some lecturers. This is not very surprising, because things get more transparent, which is not consistent with their traditional role as teachers. A lot of work and time was necessary to anchor this technical system in the teacher community. In the end, this took up far more resources than the whole programming work. To a developer of an e-learning system, it is new that you must motivate the teachers more than the students to use the system.

C) Supporting ways of active communication and collaboration: Based on empirical insights

4 It is not obligatory for German Computer Science students to attend lectures in order to take the examinations.
5 A publication that describes the technical realization is under preparation.

about the InPUD prototype, we added a discussion board about study management, the mentioned 'problem areas', and selected undergraduate courses in September 2002. The aim was to improve the transparency of successful study management factors. Information about study management and seminars was interwoven with online discussion boards. Thus, a computer-mediated knowledge sharing system was created. The knowledge sharing process was based on voluntary participation. As we will describe later, this was the beginning of an online community.

D) Continuous improvement: From 2002 to 2006, the project team enhanced the technical system and changed some things, for instance in order to improve the performance of the technical system. Meanwhile, numerous new discussion boards were added, and more information about study management was included. The InPUD community grew continuously[6].

3.2 Analyzing the implementation process

Especially from 2002 to 2006, we analyzed the InPUD community and its evolving social structures based on the following research methods.

First, in 2003-2004, face-to-face interviews with 8 experts were held. The experts came from the area of study management, had experience of 'university management', and knew web based IT systems very well. We asked what the crucial factors for successful study management were, in order to compare the experts' statements with the development of InPUD. Based on the empirical results of the interviews with the experts, we supported the InPUD community with new ideas. One example was giving members with formal roles a role name and making roles visible; for instance, the study-management advisors were labeled explicitly. Furthermore, we conducted participant observation of the online discussions in InPUD from 2002-2006. Moreover, the analysis also encompassed user statistics, communication structures as well as qualitative content analysis focused on social relationships in order to understand the social interactions.

As a result, in this exploratory action research process we identified empirically based theses about the emergence of social structures through interactive technologies. The results can be found in the following section.

4. The InPUD community

The InPUD community[7] can be described as a 'socio-technical knowledge sharing system' for Computer Science students at the University of Dortmund, Germany. It is available online at www.inpud.de. InPUD was launched in 2002. The InPUD community differs from other online communities that are built in people's spare time and are not a part of a company.

According to the characteristics given by Preece [10], the InPUD community is characterized by a large size (more than 1,300 people). The community is an extended part of a Department of the above-mentioned university and supplements the existing formal organization of the university. The primary content of InPUD is knowledge – and its

6 In 2007, InPUD 2.0 was installed. The community portal has been converted to account for the transition from the earlier national degrees ("Diplom") to Bachelor and Master degrees.

7 InPUD is an acronym for Informatics Portal University of Dortmund (Germany), http://www.inpud.de.

collaborative creation – about the study of Computer Science, its courses and study management. The students get information about how to study successfully, and the opportunity to discuss study management, content and exercises of lectures as well as seminars. Thus, InPUD helps provide and share information to improve study practices. The community exists primarily online, but also has a physical presence through physical connections, e.g., networked students in different courses, seminars or lectures.

In more detail, the InPUD community includes an overview of all classes and lectures that are offered during the course of a semester. This information is structured consistently across all lectures or seminars. Included are information about the lectures, including any tutorials which are being held (and when they are being held), course materials, notices for examinations, lecturer contact information and often an open discussion forum, as well as news and search functions.

The information and content in the area of study management have been integrated with online discussion boards. These have enabled interested stakeholders to build active social interactions. The discussion boards exist for each lecture as well as for study management. They are embedded into an information website that includes facts about course guidance as well as graphical maps that suggest which course best to study at which time.[8]

InPUD has at least two main functions:

First, InPUD combines face-to-face lectures and seminars with online discussions (blended e-learning approach). At the time of writing, 30 boards are on-line, each with its own moderator. The discussion boards include discussions about selected lectures. It is possible

- to ask something about the content (e.g., a student asked “I don’t understand why the following example isn’t a socio-technical system: <a married couple talking over the phone>. Can anyone help me to?”)
- to discuss exercises and their solutions on the discussion boards (e.g., a student asked: “With regard to the exercises <What is an appropriate definition for human-computer-interaction in contrast to human communication?>, my idea is the following. Who of you have similar or different solutions, and why?)
- to post something about the organization of a lecture (e.g., a student asked “Do we have to write an informal test at the end of the summer semester - or is it a formal examination?”)
- to make some comments with respect to the evaluation of a seminar (e.g., the students created an brief quantitative online survey about the written examination: “The written test was easy – medium – difficult.”)

Second, there are information and discussion boards that have been initiated by study management advisors, and course guidance. The discussion boards include questions and answers referring to study management, for example “*how to study successfully*”, “*how and where to register for written examinations*”, “*where to find the university calendar (timetable)*”, “*what are the contents of Computer Science courses*”, “*which semester is best suited for studying abroad*”.

The InPUD discussion-board software also provides an awareness tool that provides

8 German universities offer a multitude of lectures, and students have to create their own semester plan for lectures; meaning they can choose which lectures they attend and when to attend them.

information about activities of the users, formal roles and current status, and shows who and how many users are online at the same time.

The community members are primarily students from the Department of Computer Science, but also persons who are considering taking up studies, e.g., high school students. Other community members are advisors from course guidance and study management. The InPUD community comprises students who could theoretically meet at lectures. However, this face-to-face communication is unlikely due to the fact that the courses are oversubscribed. Sometimes there are more than 600 students on a single course - direct social interaction with each person seems to be difficult to achieve.

The InPUD community is continuously expanding, although it has grown without any marketing or any external advertising.

Since its launch in May 2002, more than 1,330 registered participants have written more than 34,000 contributions. Registration and login are only necessary when actively contributing. Observation and reading are possible without registration and without logging in. Each user has access to all available information. InPUD is used by more than 60 percent of students within the Department of Computer Science at the University of Dortmund.

The number of requests has grown consistently, and the access rate usually peaks at the beginning of a new semester. In October 2002, there were only 171,408 requests. A year later, in October 2003, there were 292,155 requests, and in October 2004 this had increased to 491,330 requests. In the last years, InPUD has doubled its requests in every year.

About 2,000 students (100 percent) are enrolled at the Department of Computer Science in Dortmund. In April 2008, more than 1,330 (67 percent of all computer science students) were registered in InPUD. About 670 students (33 percent) were not registered. We do not know if these ‘non-registered persons’ were lurkers or if they did not use the information portal. With some exploring interviews, we have found out that they might be lurkers because almost all students use the information portal.

Figure 1 shows the analysis of the communication structure: About 1,100 members (of 1,334 registered members) contributed actively. The other 229 members were registered but still did not post. We assume that these registered InPUD lurkers (11 percent of 2,000 students) wanted to show their interest in the community although they did not actively participate. According to Preece [10], there are different reasons why they do not post, for instance, no motivation, no personal need, and curiosity without exposure. Maybe they are waiting for the “right” moment to post.

A core of 263 individuals regularly provided contributions: ranging from 26 to 482 postings (questions/answers) per individual. That is a significant number. The core members are the elders, leaders and partly the regulars [8]. The other 842 active members (617 and 225) made between 1 and 25 postings each. These members can be described as regulars, too, but also included novices and visitors.

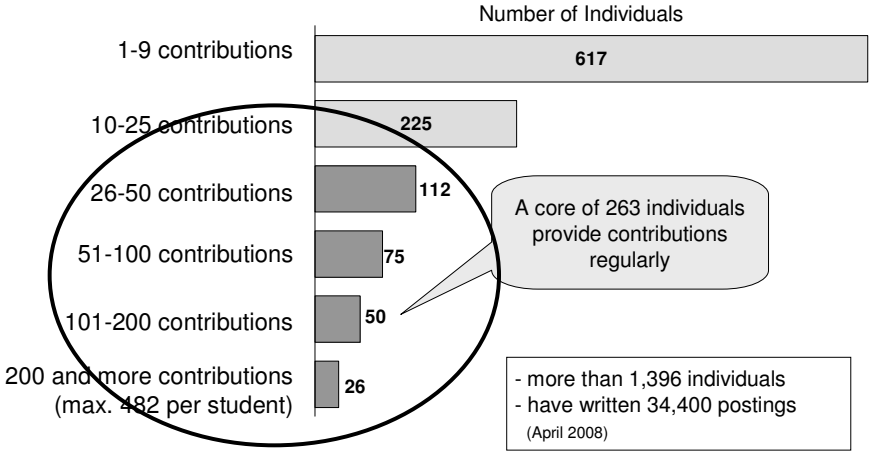

Figure 1 InPUD's communication board - Number of contributions per individual

The success of the InPUD community can be measured by the significant number of students who actively participate. More than 60 percent of Computer Science students participate and use the community's content. The large number of participants indicates that a significant number of students appreciate this form of knowledge sharing. They discuss, ask questions, answer others' questions, come up with new ideas and help each other.

5. From Teaching to Learning – supported by InPUD?

A paradigm shift is taking hold in European universities. According to Barr & Tagg [2], the old traditional paradigm that has governed our universities is this: A university is an institution "that exists to provide instructions" (Instruction or Teacher-Centered Paradigm). Such an education refers to authoritarian instruction in which the teacher directs all learning. The new paradigm is: A university is an institution "that exists to produce learning" (Learning Paradigm) in order to support learners. Student-centered, learner-centered and outcomes-based education acknowledges the learner's participation in the learning experience. It refers to strategies which put the learner in control of constructing their own learning. This paradigm takes into consideration the pace, repetition, learning styles, motivation, self-regulation, and responsibility to learn. In such an approach, there is a shift from teaching to learning where the teacher needs to take responsibility for ensuring that all students learn – and make progress. Therefore, it requires a shift from the teacher as director of learning to facilitator of the learner's direction and creator of learning opportunities.

In order to apply effective learning methods, Dale [5] has created a learning pyramid with the most effective learning methods or means. These are: "teach to others / immediate use / explain something new to other people", "practice by doing" and "discussion in a group". Methods like "follow a speaker during a 90 minutes lecture", "reading", "audiovisual perception" and "demonstration" are less effective. They do not support the learner. Instructions are still important; however, there is a balance between learner's constructional processes and well-organized processes of instructions from the teacher [3]. Table 1 shows main aspects of the learning paradigm and how they are supported by InPUD.

Table 1 Supporting the Learning Paradigm with InPUD

The Learning Paradigm (according to [13])	*Characteristics of Web 2.0 with regard to the Learning Paradigm*	*InPUD and the Learning Paradigm*
Student-centered approach: focusing on students and learning processes	Software systems that support on-line human communication; creating new knowledge by many-to-many users' communication	++ InPUD creates feedback channels: It has dissolved one-way-communication from teacher to learners, and has enabled communication channels from learners to learners and teacher
Changing the teacher's role: from instructions to creation of learning environments and situations (teaching how to learn)	Web 2.0 applications support interaction, cooperation and collaborative learning, for example with discussion boards, Wikis, blogs etc.	0 InPUD has discussion boards. This supports the methods "teach others", "discussion in a group" and "explain something new to other people". [Research question: Does InPUD need more than one collaboration opportunity?]
Supporting the learner's role	From consumer to producer ("Con-ducer")	+ InPUD supports the "Learner 2.0": From consumer to learner who actively integrates new knowledge into personal context
Focusing on learning outcomes and goals		-- InPUD enables a 24 h online participation; however, it needs more organizational and didactic commitments in order to focus on learning outcomes
Promoting self-organization and active learning arrangements	Web 2.0 enables the building of new social relationships and social networking over the Internet	+ InPUD enables students to find others with similar interests, preferences or in similar situations, and supports discussions
Connecting knowledge acquisition and learning strategies	Communication about teacher's content	+ InPUD enables students to share different perspectives

InPUD can support the shift from teaching to learning; however, today this shift is often triggered by the students. A more reflective practice is needed in order to support the shift to the learning paradigm and to improve the InPUD scenario. This includes, for example: First, in order to support a mix between face-to-face and computer-supported collaborative learning, the teacher should define what cooperation is and how a group can or should cooperate. The connection between lecture and InPUD should be taught. Second, teachers should give orientation and foster convention on how to learn with InPUD or other Web 2.0 based learning applications ("learning model"). The teacher should explicitly explain rules and expectations for using InPUD at least at the beginning of a lecture.

What we have learned with InPUD is: There is *no single learning scenario with Web 2.0* because it depends on how people participate in cooperation, it depends on different learning cultures, on the teacher's role, goals, and content and students. According to the Learning Paradigm, in our future work we will research the above-mentioned criteria for enabling "creativity supported learning environments".

6. Conclusions

We have provided some insight on how the implementation of a system based on Web 2.0

technology can successfully support the shift from teaching to learning in Informatics. The InPUD community is a good practice scenario that shows how combining face-to-face lectures and online communication works.

Designing a socio-technical community to support student-centered learning is no longer primarily a problem of programming or tailoring a technical system. Good standard software such as content-management systems can be adapted in reasonably fair time. The main task is fostering the acceptance of a system that is not compatible with the traditional structure of a university or school. In a student-centered setting, there is little need to motivate students, but a great need to motivate lecturers. Curriculum coordinators can be a great help in designing such systems. Some crucial facts for acceptance, beside self-evident facts such as ergonomic use, are:

All information must be correct. If it is not, the error must be corrected as soon as possible. All information must be available when it is needed, better a bit before that. Not all information is relevant for students, even if faculty members sometimes believe it is. To implement such a software system in a department, you have to bear in mind that you are not the only one who promises that everything will become better when someone decides to use your system. In most cases, you are not the first either, so you must distinguish your system even from systems you never thought would be competition. If you convince committees of the advantages of such a system, it does not mean that they see any necessity to pay for it, and often there really is no money. So use standard technologies as much as possible and try to tailor them according to your needs.

From the study we may also derive some insight about Informatics students and culture:

- First: Students of Computer Science are not easy to handle when you try new teaching methods that involve computer technology, because every student is convinced that he or she can do the technology better. So do not even try to impress them by sophisticated graphical design or enormous features. You will lose.
- Second: Use only technical systems which are secure and well tested. There is the danger that students spend hours and hours in trying to hack the system or in finding errors, but not in dealing with the content you want to teach.
- Third: Students of Computer Science have, of course, in their majority a great affinity to using computers. So be very careful when offering incentives to use the system. Do not make it too cozy. Otherwise students might never come out of the system to visit their lectures or meet other students in real life. Anonymous logins are crucial.

It would be interesting to combine traditional e-learning systems, e.g., Blackboard or other VLE that rather support a teacher-centered approach, with the InPUD philosophy as well as Web 2.0 concepts, and examine the results.

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