FORMAL AND INFORMAL TECHNOLOGY ENHANCED LEARNING FOR INITIAL AND CONTINUING ENGINEERING EDUCATION

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The results of two empirical surveys among students and the experiences from an interdisciplinary course show that the success of stimulating informal learning by formal learning offers is a matter of educational design as well as of attitudes towards learners and their personal development. Dialogue and immediate communication, up-to-date and relevant content as well as assignments that fit to the needs and motivations of learners are some necessary conditions for the success of interfacing formal and informal learning within initial curricula and in continuing education.

The Concept of Informal Learning

The concept of informal learning has received increasing attention in the past years. This is partly due to a growing interest in adult and life-long learning. Researchers like Malcolm Knowles pointed out that a considerable percentage of adult learning is informal and self-directed taking place outside any accredited educational institution (Jarvis et al 2003). Lave and Wenger (1991) take a similar position. For them, learning takes place in communities of practice and includes more than the acquisition of knowledge. It is basically a social activity in which also the norms, ideas and memories of a group are conveyed to newcomers. In this context, some forms of informal learning are unintentional and tacit and therefore especially hard to investigate.

The concept of informal learning is rather difficult to define. Livingstone (2001) has proposed an interesting approach. He distinguishes between two dimensions: primary agency (learner, teacher) and knowledge structure (pre-established, situational). In this matrix, four forms of learning exist. One is the traditional formal learning directed by a teacher with a given, pre-established curriculum. The second form of learning is self-directed but with a pre-established curriculum. For Livingstone, the characteristic of informal learning is the lack of a pre-established structure. In this sense, informal learning can be either self-directed or moderated by a teacher.

This implies that informal learning is not only an autonomous activity but can also be influenced by teachers or trainers. Engineering students, e.g., usually develop an identity as engineers during their studies which enables them to adapt to the social norms in this field during their working life later on. This is not a self-directed activity but rather a process strongly influenced by teaching staff at technical universities. In most cases, this process is implicit, and the participants do not reflect its consequences.

On the other hand, there is also a self-directed form of informal learning which sometimes even works against the official curriculum (Schugurensky 2000), e.g. students exchanging information about efficient strategies to cheat at tests. Other forms of informal learning can be a valuable support for the formal curriculum (e.g. students' learning groups). Students may also co-operate to get knowledge not included in the curriculum but important for their studies.

Informal learning is a very complex concept and in many cases difficult to investigate. There is still very little systematic information about the pedagogical principles which underlie this phenomenon, especially the tacit and unintentional forms.

According to Cross (2006), “informal learning is the unofficial, unscheduled, impromptu way most people learn to do their jobs.” According to our own experiences and analyses this is not only true for employees in companies learning on the job but – to some extent – also for students at universities.

Successful Informal Learning Scenarios at TU Wien

A considerable number of teachers at Vienna University of Technology (TU Wien) already design their courses according to the concept of informal learning – with or without being aware of this concept. Assignments with open structured problems to be solved in small groups are the core strategy, especially for courses offered with blended learning.

A brief questioning of approximately 40 students and 5 employees – done in January 2007 – identified the following scenarios of informal learning at TU Wien: meetings in the University Library, the Informatik-Forum (an internet forum run by students of computer science), virtual teamwork (with Google Docs), team-building, organisation and team-work with Skype, Tandem Language Learning, and a number of different Tutorial Programs (Csanyi et al 2007).

A structural analysis of these learning scenarios showed the following characteristics applying to each of the identified situations to some degree. They are *social* situations, *non-hierarchic, student centred*, *self-controlled, trustful*, and aiming at *versatile learning goals*.

Factors of Success

Like in any challenging learning situation, on the one hand, participants need specific skills on a certain level to be able to *successfully* participate. If these skills are lacking, students will not be able to benefit from the situation. On the other hand, there are some situational features which influence or even determine the chances for success.

In a second analytical step, we thus tried to identify the relevant factors of success of informal learning, and found six of them (in part applicable only to the virtual ones among the described situations – see Csanyi et al 2007):

Communication skills: Regarding students, communication skills seem to be the most important requirements for successful participation in informal learning situations which are explicitly less structured or directed by an external authority. Thus, it is more difficult to join such situations actively.

On the other hand, students have the chance to find and even set up environments according to their individual needs and premises. Informal learning scenarios do not need to be pre-established. On the contrary, they can emerge out of the moment. Consequently, informal face-to-face situations may pose the problem to overcome shyness in first contact or to balance the offensiveness vs. defensiveness of communication strategies in a suitable manner. In web-based environments, success depends highly on computer-literacy and knowledge of the existence of tools and how to handle them.

Open Access: Regarding informal learning situations in general, *open* access to a *delimited* space seems to be a critical factor. People need limits to be able to find themselves in a situation. But entering the situation must not demand too much effort. The optimum seems to lie in an open but not unconditional access. For face-to-face meetings, it will e.g. be necessary to arrange time and place with some colleagues. But there should not be further constraints to find and to join the situation like unknown addresses or locked doors. The same can be applied to virtual environments. Individuals do not meet in the internet as a whole, but in well defined spots. You have to know the address and to register to get access – and nothing else should be necessary.

Usability: Regarding web-based environments, usability plays a major role for acceptance and success. The first important aspect of usability is an easy and time saving access. A clearly laid out design (according to perception habits of the individual users) and intuitive navigation are a must as well. Copying the look and feel of frequently used software products will help to raise acceptability. In this context, usability is not necessarily following the professional standards according to scientific evidence – but the suitability to individual customs. Thus, it will not be possible to optimise one design for all potential users; each student will look for and find the optimal design for her or his individual needs.

Work-Life-Balance: As far as we can see, the chance to mix course related questions with private matters is another factor of success. When asked for defining the ideal relation between the private and the study-related share of a learning situation, students use to answer very differently: from 5/95 to 50/50. But there seems to be consensus among them that the right mix is decisive for success. To have and to *feel* the freedom to talk about personal concerns if wanted (like partner problems or fear of failure) constitutes productive working and learning conditions.

Trustful Atmosphere: The possibility (although not the expectation) of discussing private matters and personal problems as well as the readiness to ask "silly" questions requires an atmosphere of mutual trust and equality of all partners within one situation. Persons who have the authority to assess the involved students (like professors, lecturers or even tutors) could disturb or destroy such an atmosphere. They have to stay out unless students are able to communicate anonymously (by nick names) and within a sufficiently large group of participants (at least some hundred persons).

Legal Certainty: Legal questions are, in addition to the topics discussed above, possibly compromising the potentials of (formal or informal) web-based learning scenarios. We have to face copyright problems (students or teachers violate the rights of an author) – which are already widely discussed – but there is also a danger that internet service providers violate the intellectual property rights of students. A growing number of students is aware of and sensitive to this constriction of individual rights and rejects to use software under such conditions.

Initiating Informal Learning within the Frame of Academic Education

Informal learning originally was conceptualised within vocational contexts (Cross 2006): learning by doing while solving real problems and being in communication with colleagues, customers and business competitors. Informal learning in an academic context lacks some of these stimulating and motivating conditions. All the more important are educational strategies that are able to compensate such deficiencies.

Successful informal learning scenarios put a high emphasis on self-controlled learning in a trustful environment. While course-related knowledge still forms the central goal, it is complemented by a "hidden" curriculum dealing with social, communicative, and co-operative skills, creativity, etc.

To deal with today's problems, an engineer has to act in multi-actor spaces. What companies need are employees (university graduates) who are able to solve unstructured problems, work in a self dependent way and in inter-disciplinary teams, act with at least a minimum of economic and social responsibility, demonstrate leadership qualities, and show motivation and capability for self-directed continuing education. These skills are quite consistent with the "hidden curriculum" of many informal learning scenarios. Elements of informal learning can therefore help to develop the necessary skills, and thus can increase the effectiveness of continuing engineering education programmes.

As described above, we roughly know how informal learning situations are structured and what characterises the successful ones among them. What we do not know in detail is how to *initiate* successful informal learning in the context of formal academic training. To fully exploit the potentials of self-directed informal learning according to Livingstone's (2001) lack of pre-established structures, it has to be linked to formal learning situations – otherwise we would not be able to influence them. Thus, the central questions in this context are: Which framing conditions does successful informal learning need in an academic environment? How must the interface between formal and informal learning be designed?

A second brief questioning of approximately 1000 students at TU Wien was carried out in January 2008 via e-mail and a web-log. Over 40 students answered, in part with short essays of about 300 words. This survey identified several phenomena which seem to form relevant conditions (in terms of techniques, attitudes, and content features) for initiating productive

informal learning situations supplementing and substantiating the formal curriculum. They concern the didactic concept of courses, refer to learning content and learning goals, and relate to available infrastructure.

To illustrate these concepts, we describe a sample course *"Creativity Engineering"* which provides an introduction to the topics *intelligence, culture, creativity* and *ethics* in engineering to students of all curricula. The lecturers aimed at making the course a valuable multi-dimensional experience for everybody involved. Informal learning was induced in various ways combining theory with application into practice and by alternating two working- respectively learning-scenarios:

Face-to-face lectures for approximately 25 participants (lectures were run twice for the sake of a reasonably small plenary groups) presented topical and practice-oriented content and established a social situation of mutual trust and co-operation.

Heterogeneous groups (interdisciplinary, intercultural, students with different experiences – from bachelor studies as well as doctoral studies) worked in teams on papers dealing with a specific topic in a practical context.

Dialogue

According to our findings, dialogue seems to be the most effective and most important condition for successful (informal) learning, since it lays the ground for a number of detailed measures. The course is not designed as one-way communication but as an open dialogue – and like every dialogue, the outcomes are not determined. Every participant of this dialogue, teacher or student, has the same right and nearly the same opportunity to give an input. Students involved in the processes of the course and feel that it really matters what they are doing. Their activities can lead the course into unexpected directions. Some of the assignments are explicit experiments with unknown results – and the teacher also regards the personal development of the students as an individual experiment with open outcome. She or he does not have the intention to determine them, but to bring them forward according to their own goals.

An explicitly stated goal of our *sample course* was to raise students' awareness on the importance of learning from each other and from their specific backgrounds. An important precondition for this is the understanding on the level of culture, expertise, language and religious backgrounds of each person involved to enable an open and sincere communication in the group which were not only expected from the participants but also exemplarily shown by the teachers.

Diversified Assignments

One tangible factor of success – being a direct consequence of the attitude described above – is the number and quality of assignments. Each student can choose some assignments from a pool or define them themselves. Furthermore, the quality of particular assignments varies to a high degree. Many of them take an unconventional perspective on the respective problem or are packed into a humorous situation. The most important common attribute of all assignments is the short time needed to be accomplished – in relation to the expectations of participants.

In our *sample course*, the topics for the papers were selected autonomously by the individual groups and only had to be approved by the lecturer. Thus, meeting the individual interests could be guaranteed.

Topicality and Relevance of Course Content

There are two properties of the course content that seem to be crucial for the success of informal learning in formal teaching contexts. The first is the topicality of content. This refers to presentations and practical examples as well as to assignments. The latter opens the opportunity for being up-to-date even in courses dealing with the rather timeless basics of a

subject matter. Up-to-date examples illustrating the basic concepts as well as assignments for practicing and consolidation of learning outcomes stimulate learning motivation and reduce drop-out rates among students – thus fostering the success of informal learning situations.

The second dimension of content is its relevance for the academic period (years of study) at the one hand and the time after (professional, political and – maybe also – private life) on the other hand. Here, it is very important to bear in mind that relevance is not an attribute of the content, but a property of the relationship between individual, content, *and* context. What might be relevant for one person may be irrelevant for another person. As a consequence, the diversity of aspects of the content dealt with in a course is again one step to success of informal learning phases. Sometimes the relevance of a scheduled topic is not self-evident for students. In this case, it has to be revealed by adequate practical examples.

The topics for the papers of our *sample course* were selected autonomously by the teams and were thus relevant for team members and could also link theoretical lectures to application into practice.

Ubiquitous and Immediate Communication

Today's students are not used to wait if they feel the need to communicate – e.g. for posing questions or problems, or for receiving feedback, assessment, or encouragement. If the span of time between the perceived need to communicate and the possibility to come up to it is too long, the need – and with it the correlated learning or working motivation – will disappear. (This might be one of the secrets of the efficacy of informal learning.) Thus, communication speed seems to be a crucial factor of success for informal learning situations in academic contexts.

The technological implications are rather clear: required is the application of easy to handle internet- and notebook- or pda-based tools for fast asynchronous communication in written form (which is, concerning content-oriented communication, more effective than talking for a number of reasons like reflectivity, documentation, and asynchronicity). The organisational implications concern the decision who (teacher, tutors, students) will be available when to deal with which problems. It seems to be crucial that there is a contact person available for each concern reacting within an acceptable span of time.

The collaborative learning teams of our *sample course* were supported by online tutoring and coaching, available nearly any time, with nearly any communication medium, while working on their papers.

Conclusions and Outlook

Starting from the identification of informal learning scenarios in the context of (formal) academic teaching and continuing education and the description of basic structures and quality features, we found empirical indicators for helpful framing conditions and quality requirements for the interface between formal and informal learning. Detailed answers to these crucial questions will be necessary to exploit the enormous potential of informal learning which can only be utilised if linked to the formal "hemisphere" of learning.

Results from our survey among participants and from experiences with specific courses show that the success of stimulating informal learning by formal learning offers is not just a matter of educational design, but also of attitudes towards learners and their personal development. Some of the conditions for success identified by us can be implemented in continuing education even more easily than in initial curricula.

However, these findings are still on a heuristic basis and will need quantitative analyses leading to representative results. But before starting such surveys, we suggest to conduct more surveys in identical or similar ways at different universities in different countries to get a wider empirical basis for the construction of highly selective hypotheses and a well-grounded study design.

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Curricula Vitae

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