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Reality is our Laboratory:

Communities of practice in applied computer science

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Abstract

This paper presents a longitudinal study of the course ‘High-tech Entrepreneurship and New Media’. The course design is based on socio-cultural theories of learning and considers the role of social capital in entrepreneurial networks. By integrating student teams into the communities of practice of local start-ups, we offer learning opportunities to students, companies, and academia. The student teams are connected to each other and to their supervisors in academia and practice through a community-system. Moreover, the course is accompanied by a series of lectures and group discussions. In this paper we want to present our experiences and to reflect upon the design changes between the first and the second instance of the course. The evaluation of the course showed that the work on real-world problems and the collaboration in teams together with partners from start-up companies were evaluated as very positive, although design flaws, and cultural and professional diversities limited the success of the first instance in 2001. For the second course in 2002, the didactical design was improved significantly according to evaluation results, which brought evidence that the design changes resulted in better collaborative practices and more stable relationships between start-up companies and students. Furthermore, it was found that especially the differences in cultural background and different historical experiences between the two distinct groups of ‘students’ and ‘entrepreneurs’ might make processes of social identification more difficult and, therefore, successful community-building less likely.

Keywords: Communities of Practice, Social Capital, Case Study, Entrepreneurship, New Media

1 Introduction

Engineering universities have a strong record in knowledge sharing with industries, ranging from cooperative research projects to student internship linked with the engineering curricula. Start-up companies in the environment of technical institutes heavily benefit from the innovations made in

research. Surprisingly, in computer science the lab courses are organized not according to the model of engineering curricula but natural science curricula. Therefore, most computer science students do not gain contact with industry unless they work in addition to their programmes. Moreover, most German computer science faculties do not encourage entrepreneurship enough. So, even in IT-related start-ups, the founders often do not have a background in computer science. Innovative and knowledge intensive start-ups have a positive impact on the economic development of regions by fostering structural change and dynamic employment rates. With this in mind, knowledge from universities should be deployed more effectively for the future entrepreneurial activities of students. Currently, only a small amount of students start a new enterprise after working 8-15 years in the industry (Schulte and Klandt, 1996; Albach, 1998; Moog, 2000). Universities should make students more sensible of their entrepreneurial potential and help qualify them for successful entrepreneurship.

Entrepreneurship can not be stimulated and taught solely by transferring knowledge. Practice-based approaches need to be integrated. There are inspiring examples of universities that have developed such a comprehensive approach in entrepreneurship teaching, like the MIT Entrepreneurship Lab (Roberts, 1991). The Aachen region has good prerequisites to connect academic initiatives in entrepreneurship with a vivid local start-up scene. Within 50 miles of RWTH Aachen, a dozen technology parks have been established with about 500 new companies and more than ten thousand employees in the last 15 years. The major challenge is the establishment of concepts for apprenticeship learning within companies on a regular basis.

The abilities of digital media to overcome time and space barriers can support learning between universities and actors within companies. Digital media use in university level teaching is an important research area (cf. Jonassen and Mandl, 1990; Uellner and Wulf, 2000). Besides the development of adequate technical functionalities to support individual and group learning, the embedment of these technical systems in innovative didactical concepts is the main challenge. An appropriate combination of practice-oriented education at universities and concepts of learning within companies is a precondition of a successful integration of academic theory and economic practice. Identity-building in communities of practice and the building of social capital are expected to enable a fruitful exchange between universities and companies.

To tackle some of these problems, we have developed a new course in applied computer science teaching which is based on socio-cultural theories of learning. It is called ‘Entrepreneurship and New Media’. Since 2001, together with local start-up companies we organize labs where multi-cultural and multi-functional groups of students work on IT projects. In the course several groups of computer science students work on a concrete project task for a start-up company. The courses are accompanied by a series of lectures in which university lecturers and practitioners present entrepreneurship and media relevant topics. For the whole course a community-system was deployed to facilitate communication and document sharing between the different actors.

In the following paper, we want to present a longitudinal study dealing with the course ‘Entrepreneurship and New Media’. It was conducted in the winter terms of 2001 and 2002 at RWTH Aachen, and it tried to create a shared learning experience while solving a complex task (cf. Klamma *et al.* 2003, Rohde *et al.* 2003, Rohde *et al.*, 2004). In the paper we reflect upon our experiences and the design changes of the course between the first instance in the winter term 2001 and the second instance in the winter term 2002.

The rest of the paper is organized as follows: In section 2 we discuss socio-cultural theories of learning and conceptions of social capital and apply them to the learning processes in entrepreneurial networks. Section 3 presents the general concept of the university course. Our research methods are described in the fourth section. Section 5 summarizes the evaluation results of the first instance of the course in 2001 with regard to design changes made for the second

instance. In section 6 we report on evaluation results of this second instance in 2002. In the last section, our findings are discussed with regard to the application of the theoretical approaches to university courses, the building of social capital within regional entrepreneurial networks, and specific requirements for academic teachers and supervisors.

2 Socio-Cultural Theories of Learning and Social Capital

Traditionally, university teaching is based on an 'instructionist' understanding of learning. The learner is seen as a receptive system which stores, recalls and transfers knowledge. This understanding was criticized from theoretical and practical points of view (cf. Collins *et al.*, 1989; Jonassen and Mandl, 1990). Referring to these critical approaches, recent scientific theories favour constructivist and socio-cultural concepts of learning. In the last decade constructivist theories of learning played an important role in the development of new computer-based learning designs (Duffy and Jonassen, 1992). Based on the work of Vygotsky (1962), Piaget (1957), and Bateson (1973), learning is seen as an active and constructive process. In this understanding, learning does not mean the transfer of knowledge from a teacher to a learner, but rather the learner's permanent (re-)construction of knowledge, based on former experiences.
Socio-cultural theories take learning as a collective process that is linked to specific contexts of action. Knowledge emerges in communities of practice by discursive assignment of sense (Lave and Wenger, 1991; Wenger, 1998). Processes of social identification (Tajfel, 1978; Turner *et al.*, 1987) play a central role for the establishment of common practice and a shared identity. They need to be considered more explicitly in the discussion on socio-cultural theories of learning. To foster networks among student groups, academia, and start-up companies, the scientific discussion on social capital (Bourdieu, 1983; Putnam, 1993; Cohen and Prusak, 2001; Huysman and Wulf 2004) means a relevant condition (cf. Rohde, 2004).
In the following section the theoretical background for the didactical conception and the design of the course is described, including theories of communities of practice and social capital.

2.1 Communities of Practice (CoP)

Many authors found the concept of CoP helpful to understand and to support cooperation, knowledge management, and collaborative learning (Brown and Duguid, 1991; Osterlund and Carlile, 2003; Allatta, 2003). Several case studies conclude that this is true even for computer-supported, virtual or distributed communities (Orlikowski, 2002; Haas *et al.*, 2003; Eales, 2003; Arnold and Smith, 2003; Pape *et al.*, 2005; Rohde, 2004).
The theoretical approach of Communities of Practice (CoP) integrates identity theory, theories of practice, and theories of social structure and situated experience (Wenger, 1998). In their research on situated learning in working groups, Jean Lave and Etienne Wenger focus on common daily practices of group members, active membership, and in-group awareness (Lave and Wenger, 1991). The most important inclusion mechanisms concerning these communities are processes of collective learning, shared meaning and collective identity.
The authors analyzed processes of learning in organizational units. They developed their approach of CoP, which became very influential during the last years. Their findings characterize processes of learning as engagement in the social practice of groups and networks. The concept of 'community of practice' does not comprise organizations or enterprises as a whole, but (mostly informal) working and cooperation units: 'These practices are thus the property of a kind of community created over time by the sustained pursuit of a shared enterprise' (Wenger, 1998, p.45). In this approach the social practice refers to explicit and tacit knowledge and

competencies. It integrates language, tools, documents, symbols, and roles as well as conventions, norms, rules, perceptions, and assumptions.
In CoP, an individual's learning is inherent in the processes of social participation in CoP. Knowledge and learning in CoP are not abstract models but relations 'between a person and the world' (Duguid, 2003, p. 8) or 'among people engaged in an activity' (Osterlund and Carlile, 2003, p. 3). Individual learning in a CoP is mainly based on 'legitimate peripheral participation' (Lave and Wenger, 1991). That means that participation of an individual must be perceived as legitimate by the community members (e.g. through a common task or shared enterprise). During the participation process, an individual might enter the community as a beginner at the periphery and then gain a more centered position over time by acquisition of cognitive apprenticeship. Cognitive apprenticeship has to be acquired through participatory observation of experts in the CoP, the processing of simple (and more and more central and sophisticated) tasks, and a recessive coaching and feedback by the experts. This acquisition process leads to an intensified inclusion into the social practice of the community. Learning is based on this process of inclusion of outsiders, becoming more and more insiders in the common practice. The communities of practice themselves can be seen as 'shared histories of learning' (Wenger, 1998, p.86).
The development of a common practice defining the community includes the negotiation of meaning among the participating members as well as mutual engagement in joint enterprises and a shared repertoire of activities, symbols, and artifacts. This community practice is inseparable from issues of (individual and social) identity, which is mainly determined by negotiated experience of one's self in terms of participation in a community and the learning process concerning one's membership in a CoP (Wenger, 1998, pp.145ff.). The mechanism of (social) identification of individual persons in the social context of the community plays a key role for the formation of a community of practice. We can see that the CoP approach combines the 'two sides of the medal' of community participation: The social practice of the community as a *collective phenomenon* and the identity of its members as an *individual* one. CoP theorists focus on both levels of communality and individuality.
Furthermore, not only collective and individual processes are analyzed but also *productive* and *reproductive* practices (cf. Osterlund and Carlile, 2003). While a productive practice of a community is directed to find solutions to problems, fulfill common tasks, and reach the shared goal, the reproductive practice is directed to constitute and reconstitute the community itself. Thus, processes of community and identity building are central for collaborative learning. Concerning our lab course and the support of community-based learning in University education, we have to take these theoretical approaches into consideration.

2.2 Social Capital

For societal and political networking processes, the paradigm of social capital gained prominence. During the last years the social capital approach is increasingly adapted for the analysis of cooperation in (NGO) networks as well as of collaboration in companies and working groups. For computer-supported communities, the role and relevance of social capital have been discussed by Huysman *et al.* (2003) and Huysman and Wulf (2004).
Nevertheless, the concept of social capital is not well defined and is used by various authors in different ways (e.g. Putnam, 1993 and 2000; Bourdieu, 1983; Cohen and Prusak, 2001). Bourdieu defines social capital as the actual and potential resources that are based on ownership of sustainable networks, of (institutionalized) relationships, and mutual respect (cf. Bourdieu 1983). He analyzed the relation of social capital and economic, symbolic, and cultural capital and describes social capital as the (individual and social) reputation that is needed to enter the 'good

society' and the political sphere. In this perspective, social capital is a mechanism of political inclusion/exclusion.

To adapt the concept for collaboration processes in companies, Cohen and Prusak conclude: 'Social capital consists of the stock of active connections among people: the trust, mutual understanding, as well as shared values and behavior which bind the members of human networks and communities and make cooperative action possible. (...) Its characteristic elements and indicators include high levels of trust, robust personal networks and vibrant communities, shared understandings, and a sense of equitable participation in a joint enterprise - all things that draw individuals together into a group' (Cohen and Prusak 2001: p. 4). The authors refer to the concept of social capital mainly to analyze and support information and knowledge management within companies, departments, and working groups.

Concerning processes of gaining and fostering social capital, the approach assumes that it is accumulating when it is used (productively), otherwise it is decreasing. In this sense social capital tends to be self-reinforcing and cumulative. People gain connections and trust by successful cooperation, and these achievements of networks and trust support good cooperation in the future. To gain and foster social capital, Cohen and Prusak suggest the following (organizational) investments in trust building processes: According to their suggestions, social capital can be gained by being trustworthy, by being open and encouraging openness, and by trusting others (Cohen and Prusak 2001: p. 45f).

In the case of learning processes, social capital theorists refer to these mutual relationships of trust and trustworthiness to explain the social exchange of knowledge within networks. Learning takes place in social networks in which members share their knowledge with each other. According to Duguid (2004), social capital theory 'points to the unseen links, CoP theory points to unseen boundaries (…) that divide knowledge networks from one another' (p.1). Contrary to the social capital approach, which underlines peoples' willingness and ability to share knowledge and experiences in social networks, CoP theorists differ between willingness and ability. It is the common engagement in a shared practice of a community that makes individuals able to share knowledge and experiences and therefore, learn from each other.

However 'CoP analysis accepts the importance of social capital networks to understanding why people will and will not share' (Duguid, 2004, p. 1), the CoP approach takes communities and networks as well as their internal communication as more complex than social capital theorists. Only the analysis of a (well-) defined and established common practice can explain why people (whose willingness to share knowledge, experiences etc. is given by social capital ties) are able to share know *how* (which is mainly characterized by a tacit dimension). The ability to share knowledge therefore depends on a basis of common experiences and shared cultural values or commitments (Duguid, 2004, p. 8).

Nevertheless, we assume that the Social Capital approach will help us to understand processes of networking of regional entrepreneurs and networking of students with these entrepreneurs better. In contrast to the CoP approach, the concept of social capital does not focus on a specific practice and a common culture but rather on an analysis of mutual relations of trust and trustworthiness. We assume that cooperation between university students and entrepreneurs will enable and support the formation of mutual trust.

3 Design of the Course

Based on the theoretical foundations sketched above, we conceptualised the course as shown in figure 1. A major part of learning was supposed to happen by legitimate peripheral participation in the community of practice of the start-up companies. We intended to support processes of social capital-building between entrepreneurial practitioners and university students. The cooperation between students and practitioners at a common real-world task should allow the establishment of a shared practice and therefore mutual learning. According to the theoretical approaches presented above, we set up a practical university course based on the concept of communities of practice between students and company practitioners. The common definition of a shared task and a series of organized meetings between students and practitioners was expected to help the establishment of social capital. Guest lecturers and academic instructors accompanied the practical work in these CoP (cf. figure 1). While the course was redesigned after the first instance to meet the design goals more effectively, the basic approach described here was kept over all instances of the course.

Group oriented learning processes, especially among the student teams and between them and their academic advisors can be facilitated by a community system. Thus, the instructors put task relevant learning materials on the community system. Additionally, instructors were available for consultancy and supervision. The weekly lecture series supported the reflective processes of the students related to their tasks. Moreover, it was supposed to work as a forum of discussion among students and guest lecturers from industry and academia. While initiating learning processes among the students, the course design supported the knowledge transfer from academia to industry, as well. Discussions between students and practitioners were thought to be the starting point of learning processes in practice.

The course was developed for students of the German diploma studies on computer sciences and international students of the master programmes on software systems engineering and media informatics offered by RWTH Aachen and Bonn-Aachen International Institute of Information Technology (B-IT). Therefore, the language of the course was English. The syllabus of the course as well as the complete schedule were put on a website accessible by the students and linked within the community system and the campus wide information system of RWTH Aachen (CAMPUS).

The schedule contained a fixed meeting per week, the review dates, the planned workshops and a tentative list of lectures given by external speakers. Because of the high workload of the entrepreneurs, shifts in the schedule happened. As a technical infrastructure, a community system was deployed by the lab groups. The system supported cooperation within and between working groups. Furthermore, the external lecturers were asked to be at students' disposal after their lectures. Moreover, the system had been used as a knowledge archive for lecture and project materials. In order to find these materials, the system offers various retrieving possibilities. Additional programming tools, like a source code management system and various editors have been installed to support community-oriented work settings.

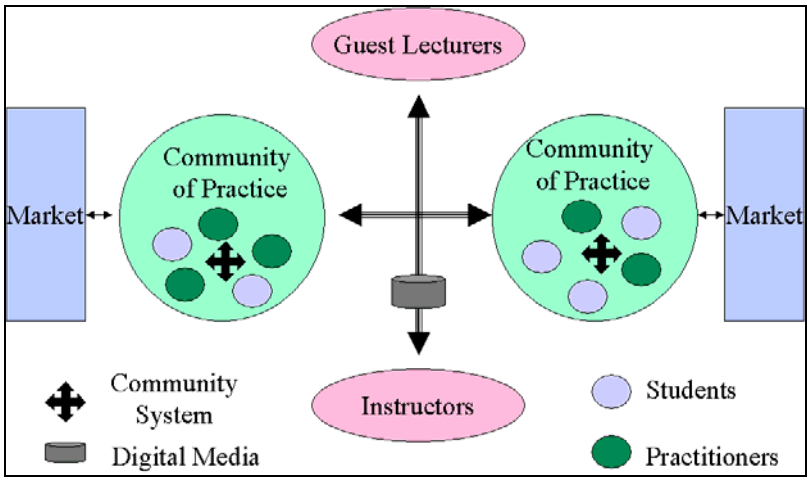

Figure 1: Design of the computer supported course 'Entrepreneurship and New Media'

In the first meeting at the beginning of the winter term, the interested students in the course were introduced to the basic concept of this type of courses; the tasks were presented briefly and lab groups were formed. Usually, the number of students interested in the course was higher than the number of students interested in the lab as well. In the first meeting the students chose one of the presented project tasks and formed appropriate working groups (Labs). Projects were always suggested by local start-up companies in the region. The companies and the designer of the course developed the projects jointly. We calculated 50 hours of student time for the course itself and 150 hours for the project lab. Each student had to spend at least one day per week on the lab. As the lab was intended for students in computer science, the definition of goals was rather technical. At the end of the term the students should be able to present a so-called alpha prototype, a kind of feasibility study. To reach this goal, students should apply project management techniques presented in the introductive workshop. A second goal within the lab was the founding of a virtual company. With respect to this, students should develop a marketing concept for a product and should be able to present the product as a solution to customer needs in a business-focused presentation. Very early in the term, the lab members had meetings with their start-ups to gather information about their objectives, projects and working methods. The lab groups and tutors compiled and agreed upon concrete project goals and a realistic project schedule which was to be reviewed in the first review meeting.

In the following week, a two-day workshop took place that introduced a specific software engineering methodology. In the workshop the students implemented a little tool by using the software engineering method and with the help of the project management technique lessons. The instructor played the customer and a short review was performed at the end of the second day.

With regard to the accompanying lecture, speakers from academia and practice rotated. The external speakers were not primarily scientists (although they could be), but entrepreneurs. These experts presented their experiences. The students got perspectives from management consultants, venture capitalists, software developers, and personnel specialists.

In the lab reviews, the lab groups presented their results and discussed the procedure further. So these review sessions also helped to exchange experiences and offered the opportunity to benefit from the progress and findings of other lab groups. At the end of the term, students, lecturers, and entrepreneurs had a final meeting. The results were presented by the lab groups and discussed.

4 Research Method

We used different qualitative methods for the evaluation of the course. The lecturers composed protocols concerning their lectures that stated progress, discussion with students, and other characteristics. For external lecturers, these protocols were composed by university members. Interaction within the community-system was recorded as well as email-exchange between students and their cooperation partners in the start-ups. As part of the final event following the presentation of the project results, a 45 minute open discussion took place in which students, lecturer, and cooperation partners from the start-ups participated. Students were asked to give a feedback concerning concept and structure of the course. This discussion was recorded.
Additionally, explorative semi-structured in-depth interviews with students and supervisors from academia and industries were conducted. After conclusion of the first course in 2001, seven partly-structured interviews with all five students of the labs and both supervisors from the start-ups had been conducted. For evaluation of the second course in 2002, fourteen interviews with students, three interviews with entrepreneurial supervisors, and one interview with an academic teacher were carried out (cf. table 1 and 3). While the above mentioned inquiries were done by the supervisors, the interviews were led by a scientist who was not involved in the lectures. In the interviews, which lasted between 60 and 180 minutes, students were first asked about their personal background, their background of education and their motivation for participating in the lecture. After that, students were questioned on personal impressions and assessments of the course and its single components. Students were also asked to suggest improvements. In the interview, lecturers were questioned on their personal background and high emphasis was placed on assessments of the lecture-components held by them. Each person was interviewed in an individual session.
All interviews have been recorded with a DAT recorder and fully transcribed. In the evaluation, the answers were transformed into a table categorizing the role of students, academic, and entrepreneurial supervisors. The interviews with non-German students were conducted in English language and translated afterwards. The interviews have been analyzed descriptively according to our heuristic approach.

5 Evaluation of the courses

According to the results of the first course in winter term 2001, the course was evaluated and redesigned. The following table shows the participants and different roles in the first instance of the course:

Table 1. Participants and Roles in the first course (2001)

	Students	Entrepreneurs	Tutors	Instructors/Teachers
Lab 1	2 German Students (male)	1 Supervisor	X	2 from University 6 extern Practitioners as Guest Lecturers (Business Angels, Personal Manager, Marketing Experts etc.)
Lab 2	1 Georgian Student (male) 1 French Student (male) 1 Indonesian Student (male) 1 Chinese Student (female; left the group)	1 Supervisor	X	

In the following we report on the empirical results of the first course and the (re-) design requirements for the second one. Subsequently, the evaluation results of this redesigned second course will be presented and discussed.

5.1 Evaluation results of the first course

From a result-oriented perspective, the course as a whole can be rated as successful. In both of the lab groups, the technical solutions required by the start-up companies were developed. In lab group 1, a functioning internet site was developed, which includes in addition to a presentation of the start-up partner (as research institute) and some of its projects, discussion forums, a small authoring system and graduated access permissions for various target groups. Lab group 2 realised a functioning prototype of an internet-based shop for antique furniture that allowed navigation and specialized searches for various criteria.

In the following section, the main results of the empirical evaluation of the first instance will be presented with regard to the redesign requirements for the second instance of the course (see more detailed Klamma *et al.*, 2004; Rohde *et al.* 2004).

The establishment of communities of practice *between employees of a firm and students* has to be regarded as less successful with respect to both of the lab groups. At first, the lack of economic stability of the two start-ups proved to be a major problem. Furthermore, the selected organizations proved to be too small for minting a common practice covering the whole spectrum of project tasks. At last, especially incompatible social-cultural backgrounds and incommensurable mutual expectations proved to be problematic for the establishment of communities of practice between the two start-up companies and the student teams.

The social ties developed *among the members of the student teams* were much deeper and much more focused on common work practice. But even the communities within the labs faced problems: Lab 1 consisted of two students not knowing each other. One of the students was an experienced industry-level programmer while the other was without practical experience in programming. His willingness to learn, however was appreciated by the other student. Lab 2—consisting of four international students at the beginning and three at the end of the course—had a much more complicated community-oriented learning process. There were not only differences in coding experience but also in team-building capability that were caused by differences in their cultural background. In both lab groups learning progress was made by common work of the engaged students. Especially in lab 1, it became evident that prior experience gained in industry CoPs could be very useful. Professional identity gained in professional practice helps shape the student CoP.

Instructors play a key role in the chosen design of the course. They are responsible for acquiring start-up companies suitable for the student needs, they select the students and support their team-building processes, they invite the external lecturers and organize lecture series, they prepare and perform the tutorials, they organize und supervise all the reviews, and finally, they advise the lab groups as moderators in the dynamic learning processes. Thus, preparation of such courses turned out to be very time consuming and instructors were not always able to give enough support due to other research and teaching commitments. Supervision and review organization were clear critique points claimed by the students. The instructors felt to be in a dichotomous role. On the one hand, they are moderators within the CoP, on the other hand, they had to assess the individual performance of each student. Fruitful discussion among moderators and students happened when the formal review process was finished. This is a clear hint that the implementation of innovative didactic concepts is always contextualized in existing cultures of teaching and learning (Wenger 1998).

Both lab groups used email and telephone quite frequently and met several times a week face-to-face in the computer science department. As a technical infrastructure for the course, a community-system was deployed to the lab groups: CommSy, a system developed at the University of Hamburg, is a web-based cooperation platform that provides different working areas in which libraries with (specialized) literature, black boards for announcements, and thematic discussion forums are offered (Jackewitz *et al.*, 2002; Janneck and Bleek, 2002). For the lectures, a working area named 'StartUp-CommSy' was created. The community system CommSy was mainly used by the instructors to distribute the learning materials of the lectures. However, the community platform was not frequently used. Analyzing the reasons for the sporadic use of the systems, we have found several reasons. First, the lab groups were quite small. Therefore, the coordination overhead was humble. Moreover, the opportunities to meet physically within the lab groups were quite good. In the interviews the students stated that the grade of interaction in the system was too low because the 'critical mass' of people involved was not reached in the course. Furthermore, the instructors did not motivate the students enough.

5.2 Redesign of the course

To sum up the shortcomings of the first course, on the level of CoP between students and start-up practitioners, the cooperation was less successful because:

- The start-up companies were very young enterprises that had not established a real consolidated practice;
- The start-ups were very small enterprises with only few employees and therefore only very limited resources to supervise the lab groups;
- The supervisors were not very experienced in organizing the course and they were not known very well in the local entrepreneurial scene;
- University students and start-up practitioners had different socio-cultural backgrounds; and
- The distance between the start-ups and the university led to electronically mediated communication and cooperation, which makes peripheral participation in CoP more difficult.

On the level of cooperation with academic instructors and teachers, interviews showed evidence for a higher level of academic support. Besides the good cooperation in both labs, the students asked for a tutor who would be able to support them in coordinating their activities. Furthermore, they defined their need for more review meetings during the course.

Concerning the cooperation platform, lab group members mentioned lacking requirements for applying the system from the side of the teachers. According to these results, the following changes were made to redesign the course for the second run in winter term 2002 (cf. Rohde *et al.* 2004):

- Start-up companies have been selected that were more stable than the first two companies. Two of the three new companies, engaged in the second course, had been founded earlier and had a longer history, better established practice, and more employees. The third start-up was still in its foundation process but worked together with a well-established strategic partner.
- Furthermore, the three companies had developed a more profound practice with respect to software development.
- Bigger student groups were established. Each of the three groups started with six members.
- Each lab group was supervised by a specific tutor.
- One of the initial lectures dealt no longer with UML but with Extreme Programming (XP), because XP seemed to be more appropriate for short-term software development projects within smaller teams.

- The course was accompanied by six students from the department of organizational psychology, which supported the lab groups by intense coaching and training for presentation techniques. The students were supervised by a senior researcher.
- We conducted four review meetings during the second course (instead of two review meetings during the first one). The reviews were taped on digital video and analyzed by the psychology students to give the lab students feedback on their review performance.

Moreover, in winter term 2002 we chose the BSCW system as a technical infrastructure for cooperation (cf. Bentley *et al.*, 1997; Koch and Appelt, 1998; Appelt, 1999). Due to the disappointing experiences in the first instance of the course, we carefully designed an introduction process that was supposed to provide additional external motivation to apply the system. The introduction process followed the guidelines developed by Bleek *et al.* (2000). In the first meeting, photos of each participant were taken and the first task for each student, supervisor, and support staff member was to create their personal home page using the BSCW functionalities for user management. Thus, users got acquainted with the system quickly and barriers to further use were lowered. Some initial documents were uploaded, e.g. a survey of the course, slides of lectures, and useful materials from the previous year's course. However, the structures to organize their labs were created by the student groups themselves. Finally, all participants were strongly encouraged to use the system. Contrary to the first instance, university teachers and tutors used BSCW more frequently themselves and defined concrete tasks to be carried out with the system. Thus, the (external) motivation to use the community system was increased significantly.
The following table indicates the design changes made to the second instance of the course with regard to the evaluation results of the first instance:

Table 2. Design Changes between first and second instance of the course

1st Instance (WT 2001/2002)	2nd Instance WT (2002/2003)
Very new, young and small companies	Older, more established and a bit larger companies
Academic lecturers/instructors, external lecturers, enterpreneurial supervisors	Additional academic tutors, 6 psychology students as coaches for presentation
Very small lab groups (2 to 4 members)	Larger lab groups (6 members)
2 review meetings	4 review meetings
CommSy	BSCW
UML	XP

5.3 Evaluation results of the second course

During the first meeting of the second course, the students built three teams. This group-building process was self-organized by the students without intervention of the supervisors. All of the labs teams consisted of six internationally mixed students: besides four Germans, there were students from Turkey, Greece, Macedonia, Ghana, India, and Pakistan. A start-up company practitioner and an academic tutor were assigned to each group.
The first group cooperated with a five-year-old software company of 25 employees, developing applications for internet banks and their customer management. The student group was supposed to develop a set of web-based applications that converts financial data like investment portfolios

automatically from XML to Java applets, C# dot.net applications, SVG files or Flash animations. These web-apps were used in customer consultations.
The second company worked in the field of e-learning since 2000. It marketed an authorware environment and a tool kit for learning and competence management in medium-sized and big companies. The company employs five developers. The students were supposed to develop a personnel diagnosis application for matching candidates' profiles with job requirements to identify training needs.
As a third partner, a two-person entrepreneurial team participated. It planned to establish a company for fraud detection on the internet focusing on the detection of graphics that were protected by copyrights. The search engine with around 300 million graphics had been licensed from the strategic partner who also delivered the database interface to the search engine. The strategic partner was well established and provided support to the lab group. The task for the group was to implement the business model with a web-site and an automatic back end for searches on the subscription base.
The following table shows the distribution of students and supervisors/instructors in the three groups:

Table 3. Participants and Roles in the second course (2002)

	Students	Entrepreneurs	Tutors	Instructors/Teachers
Lab 1	4 Indian Students (male) 1 Ghanese Student (male) 1 German Student (male, left the group)	1 Supervisor	1	2 from University, 6 extern Practitioners (Business Angels, Personal Manager, Marketing Experts etc.), 6 Students of Psychology, teaching Presentation Techniques
Lab 2	4 German Students (1 female, 3 male) 1 Greek Student (male) 1 Turkish Student (male)	1 Supervisor	1	
Lab 3	2 Indian Students (male) 1 Pakistanian Student (male) 1 Turkish Student (male) 2 German Students (male)	1 Supervisor	1	

After the course 14 (of the 18) students, all of the three company practitioners, and one teacher were interviewed, each in an individual interview session (1 interviewer, 1 interviewee). The duration of interviews was between 30 and 60 minutes. Again, all interviews were conducted by an external interviewer, recorded on tape and completely transcribed. The interviews with non-German students were conducted in English and translated afterwards. All interview statements have been structured using an excel spreadsheet
Concerning the results, two of the start-up supervisors evaluated the work as successful, while one entrepreneur showed dissatisfaction.
The overall learning experiences have been evaluated quite positively by the students. This is due to the following factors:

- Working on practical real-world problem solutions;
- The cooperation with real partners from start-up companies;
- The cooperation in teams;
- Practical experiences with presentation techniques in the review sessions;
- And the application of extreme programming (XP).

In the following section, more detailed results of the evaluation are presented. All reported results are taken out of the interviews. Most of them represent condensed interview statements. Some interview statements will be presented as direct quotations.

5.3.1 CoP within the lab groups

The establishment of a common practice was quite successful within the lab groups. The groups were stable during the course, except lab 1 in which one German student of management sciences left the group after two months because he missed economic lectures and content. The group faced some problems after he resigned because he had taken the role of a presenter. Apart from him, the lab consisted of one Ghanese and four Indian students. The Indian students tended to exclude the Ghanese student on occasion by using their mother tongue in group discussions. After some conflicts in this group the course was wrapped up by the remaining group members in a successful way. An interesting observation was the fact that one group of Indian students used their social network in India for coaching. In the case of coding problems, they used their mobiles to contact people in India to help them instead of asking the supervisors or local support staff. This behavior changed over time as far as we could observe.
In the other lab groups, the cooperation was less problematic. All participants underlined in the interviews that the close cooperation in the labs was one of the main learning effects. They expected that the established cooperation and relationship would last longer than the course:

> 'With help from the team and the people in the group- funny people - it was fine. They tried to help me and then I felt as being a group member. I meet them every day and we can make jokes together, just small talk and so on. This evening we meet again. (…) I think we have established a good friendship'. (interview lab 2)

The group structure was developed through self-organization and was described as non-hierarchical. On the other hand there were people who proved to be of higher competence than others and were highly-engaged. Some of the students and one of the tutors state that it would be better to establish a formal leader of lab groups to draw decisions and coordinate the process. With this regard, the role of the group supervisor has to be examined carefully. One of the major design changes was that the groups now have a distinguished supervisor. The supervisor was responsible for establishing the contact between the group and the start-up company, for the facilitation of meetings, for the allocation of rooms, lab places, software and books, and for the consultancy of the groups in daily work and around reviews. Each supervisor interpreted his role in a different way, which was reflected by the students in the interviews according to their cultural background and their role in the CoP.

> 'Great, I think [B2, name of supervisor 2] did more than he was supposed to do, as it was his own practical work. The relation with him was very good and one could speak with him very easily, we always could get access. This is the most important in my eyes, that he is available. (…) Maybe he could have been a little bit stricter. I think [B3] was a little bit stricter and this maybe was better.'

Another student stated that he liked his own tutor very much,

> '…but I think the other tutor [B1] is quite angry towards the people. I don't know, maybe he does that to get more out of us, but I don't like this style and behaviour.

While one supervisor appeared to be very managerial and tried to compensate for the lack of contact between the start-up company and the students, the other supervisor was very colloquial and took part in many social activities of the CoP. The implementation of such concepts depends deeply on the changing role of university-level supervisors. They are challenged by the intensity of temporal and emotional engagement as well as by the needed professional qualification. By monitoring the three different supervisors, we can confess that they play out their role in different ways. For further studies on the interplay between teachers and learners in university CoPs, our theoretical setting can be used as a framework.

The design of the project is a complicating factor when comparing the different CoPs. In one case the project turned out to be a more research-oriented project than a development-oriented project. The group did a great job in researching the necessary technologies, which helped the start-up company to identify future areas of competencies for the software development process. Another group faced no difficulties in the project because of their level of technical mastery. Therefore, they had little need to apply new methods to help them out of a jam. Identification with the problem helped students to recognize themselves as being a member of a group, especially in contrast to members other groups. This is a hint that the level of engagement can be influenced by the amount of trouble involved in the project.

The training for presentation techniques was introduced as a new module into the course. This was appreciated very much by the students. Support for this was organized by students of psychology and their instructors. Every review included a talk by some group members. These talks were taped on digital video in a specially equipped seminar room and post-produced in the computing center. After an analysis phase the psychology students conducted special feedback workshops with each group to find problematic aspects in the presentations and opportunities to improve presentation techniques. In the middle of the semester a full day workshop was conducted to introduce general techniques applicable in scientific and business presentations. At the end of the semester entrepreneurial presentation techniques, like elevator pitch and focused customer presentations were additionally introduced and applied in the final review as well as in the public presentation of the projects. The social ties between the students in the group and the psychology students developed very intensively.

> 'I want to thank the psychology people. (…) This was very important for me personally. (...) It is very important to make other people think and feel like we do, and the psychologists were very helpful. And for a start-up company presentation techniques are very important'.

One of his colleagues added:

> 'Yes, the workshops helped me a lot to improve my presentation techniques (…), the [psychology] students were very sympathetic and cooperative.'

Some of the students turned out to be very good presenters in the end, comparable even to those trained in MBA courses like the Ghanese student who did an impressive presentation. This additional training in presentation techniques successfully support students in their presentation and help in shaping CoPs by additional common practice and further identity-building.

5.3.2 CoP between students and company practitioners

As in the first course in winter term 2001, the establishment of CoP between students and the company was limited. A real participation of students in the companies' communities of practice could not be established. In case of the third company, it was not stable and old enough to offer an established practice in which the students could become enculturated. On the other hand, a very good relationship between the entrepreneur and students emerged due to the very intense engagement of the company founder:

> 'One meeting every week, at Wednesdays. We give him our results and he tries to give us ideas how to proceed. If he has got doubts, he asks directly. He is a really nice guy, very cooperative and helpful (…) He is very friendly, just like a group member.'

The entrepreneur confirms a good atmosphere but is disappointed with regard to the work result, because the competences of students did not fit his expectations. On the other hand, the students and the tutor stated that the task definition was too fuzzy to solve the problems in time.
The second lab group shows a different picture. Here the result of the work was very successful while the personal relationships between students and the entrepreneurs were not that good.

> 'Cooperation was poor – I would say. It is a spin-off and our first supervisor was expelled during the course. (…) This was the one, we negotiated the task requirements with. And then his successor came and said: 'I don't know what you have talked about with my ex-colleague before'. That caused chaos. (…) The company was located in Bonn (…) and the lad had not enough time to be here at the university every day'.

This quotation shows that fluctuation in the personal of the start-ups and spatial distance disturbs the participation in the companies practice. Furthermore, the entrepreneur behaved like the leader of the group:

> 'Yes, he was our chef in any sense. (…) he decided what to do. Yes it was not a good relationship, we saw him only two times'.

The second entrepreneurial supervisor evaluates the cooperation differently:

> '(…) I am very satisfied. We liked this kind of interaction very much, how this was built up. I am very satisfied with the results as well as with the cooperation'.

On the other hand he states:

> 'They [the students] were not really integrated in the company's practice, in the sense that they worked here at the company's location. Nor did they take over other tasks (…)'.

The first lab group met with their start-up supervisor only two times during the course. He was part of the management of the company and had not enough time to show up more. But the students understood his limited resources and sent him written reports on their work progress weekly. Nevertheless, all students stated that they were very satisfied with the results and that they had learned a lot. The supervisor agreed on the students' impression. He argues that

> '(…) Integration [of the group] in business processes could not work with this structure. The whole group had to work inside the company, or minimal two or three of them to design a clear communication interface'.

This can be seen as a hint that processes of 'generalization' and 'accentuation' (Tajfel, 1982; Turner *et al.*, 1987) are working within the initiated CoP: Amongst the students, 'in-group' phenomena of social identification occurred, while between students and entrepreneurs (as 'out-group' members) identification is less likely. Therefore, community building of members of distinct social groups with different cultural and historical experiences might face specific problems of understanding and need advanced coordination efforts.
The role of the software-engineering method needs to be investigated further. Extreme programming (XP) was introduced as it is supposed to be more suitable for short-term projects with small development teams compared to UML and the unified process. Moreover, regional start-ups already had positive experiences with XP. Most of the students were very pleased with the method itself but difficulties when applying all the XP rules were obvious. In case of urgency, students forgot all principles and returned to the 'good old hacking' approach. The companies were very interested in the XP approach. However, their software engineering methods were even less developed than the ones of the students. Our observations are consistent with the debate about XP in the last years (cf. e.g. Stephens and Rousenberg 2003) and a CoP aware software development method is still an open issue.
To sum up the interview results, we can see that limited resources (both persons and time), spatial distance, cultural differences, and incommensurable expectations hinder the establishment of CoP between university students and company practitioners (cf. Rohde *et al.*, 2004). So the realignments taken did not lead to better overall enculturation processes of the students into the companies' CoP.

5.3.3 Technological support by the cooperation platform

Contrary to CommSy during the first course, BSCW was used very frequently by all groups and students. This was due to the strong recommendation from the supervisors to use the system for cooperation and the necessity of carrying out certain tasks by means of the groupware (e.g. filling in personal data and upload a photograph). Furthermore, the lab groups were bigger and the start-up practitioners used the system more intensely than in the first course.
All interviewees evaluated the usage of BSCW as very positive:

> 'Role of BSCW should not be underestimated. It is very helpful for us (…) We use it for everything, for upload of developed applications, for organization of meetings, for weekly reports. To say it in other words 'Everything we do, can be found in BSCW'. (…) If you are working with BSCW it is like being together with all of us'. (interview lab 1)

A member of lab 2 states very clearly:

> 'I log in to BSCW nearly every day. It plays a role like a group member'.

The groupware system was used for the up- and downloading of documents, for discussions in forums, for co-authoring of documents, for annotations, and for awareness information. However,

for planning activities and meetings, other media, like phone or e-mail, were used instead of the cooperation platform.
Interviewees named some shortcomings of the BSCW system: They missed features for synchronous communication like chat. The up- and download of documents was evaluated several times as too complicated. The group awareness support (Preece 2000) of community systems is crucial for the establishment, maintenance, and development of CoPs. It helps in fostering trust and team spirit.
The introduction process for the community system has to be designed carefully to reach a mission critical use of the system during the course and later on. Barriers in using the system, which can be observed in student groups using the same system without such an introduction process, were lowered by enforcing the first guided steps. Consequently, the use was very intensive, lasting far beyond the time line of the lab course.

6 Discussion

Socio-cultural theories of learning stimulate the design of practice-based courses in applied computer science. We have presented empirical findings concerning a lab course that was accompanied by a series of lectures and supported by digital media. This course design is different from traditional internships in industries in which students are not supported by university teachers to such an extent. The results of the evaluation have shown that both networking on a technical and a social level offer new opportunities for university-level education.
The work on real-world problems and collaboration in teams with partners from start-up companies were evaluated as very positive. Following a first instance of the course, the didactical design was improved significantly according to evaluation results. By a more precise selection of start-up partners, larger lab teams, coaching of the lab groups by tutors, and increased motivation to use the technical community system, collaboration and, therefore, the establishment of a common practice within the lab groups were improved. Furthermore, additional engagement of students of organization psychology, certain training (e.g. presentation techniques), and the conduction of more review meetings, led to a better evaluation of the second instance.
In the first instance of the course in 2001, design flaws, cultural as well as professional diversities, and imponderableness of reality limited the success. Although the second course, in winter term 2002, was based not on a different or new didactical design, but was an organic advancement of the first instance, the mere redesign in the second instance resulted in better collaborative practice and more stable relationships between start-up companies and students. Most important barriers for the establishment of CoP between university students and start-up companies are limited resources (time and persons) and cultural differences. The differences in cultural background and different historical experiences in the two distinct groups of ‘students’ and ‘entrepreneurs’ might especially make processes of social identification (cf. Tajfel, 1982) more difficult and, therefore, successful community building less likely. According to identity-building processes of social categorization, generalization within ‘in-groups’ leads to reinforcement of perceived similarities, while accentuation between members of different ‘out-groups’ increases perceived differences (cf. Turner *et al.*, 1987). This perception of *intra-group* similarities and *inter-group* differences might hinder the establishment of CoPs between members of different group and should be taken into account with regard to the design of supporting conditions for the initiation of communities of practice.

Nevertheless, good personal relationships and therefore rich social capital were established between some students and practitioners. Self-organized and non-hierarchical structures supported the building of social capital within the lab groups. In all lab groups, learning mechanisms of legitimate participation have been successfully proven. The students especially reported on high intensity learning in their collaborative practice in the lab groups.
Did the students learn how to network? Students within the lab groups built up social capital leading to relationships beyond the scope of the course. Furthermore, the lab students do joint work in other contexts like course homework or master thesis work. Some of them have the same cultural background but we can also observe cooperation between students from different countries but the same year.
We can monitor that the students still use the BSCW system, especially for downloading materials not stored elsewhere like videos taped in the review sessions and personal information about other lab members. The personal reputation of the supervisors from the university in the entrepreneurial networks has been leveraged by the courses. The supervisors are included in information exchange networks and invited to start up related events like business plan competitions, company fairs and so on. The contact between the course supervisors and the local university entrepreneurship centre, from which lecturers were invited to present in the course, and the common lecture series both helped in establishing stable relationships and social capital.
Further development of university structures is needed, but also new potential for universities are offered by networking with local industry and life-long learning activities within continuing education. The course has been conducted several times in the following years, not only at the same university (RWTH Aachen) but also at the University of Siegen. The analysis of the empirical data of these courses is currently ongoing work. The concept of the course is used to design new pan-European master programs that exchange third country and European students between different European universities to foster student mobility and the exchange between European universities and industries.

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