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Special Issue on "Computer Support for Learning Communities"

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Introduction:

Computer Support for Learning Communities

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This special issue emerged from two workshops on community-based learning: one at the Sixth International Conference on the Learning Sciences (ICLS 2004), held in Santa Monica, CA, and the other at the International Conference on Computer-Supported Collaborative Learning (CSCL 2005), held in Taipei, Taiwan. A call for papers was issued as a follow-up to these stimulating workshops; 16 papers were submitted, of which six were accepted following a rigorous double loop peer reviewing process. This special issue is part of a wider discourse on learning communities, specifically the conferences series on Communities and Technologies and related publications (Huysman *et al.* 2003; Ackerman *et al.* 2003; Huysman and Wulf 2004; Klamma *et al.* 2004; Stahl 2006).

Within the perspective of the history of computers, interest in computer support for communities represents a logical progression. In the mid-twentieth century, computers were viewed as self-contained machines; designer's concerns stressed internal efficiency in terms of logical operations and memory allocation. It took visionaries like Bush (1945) and Engelbart (1962) to conceptualize computers as extenders of human intellect. Then designers had to consider human-computer interaction, how individuals actually used computer tools. Although the visionaries provided glimpses of inter-personal implications, most software development focused on tools for individual users and at best took into account human psychology.

More recently, the fields of Computer Supported Cooperative Work (CSCW), Computer Supported Collaborative Learning (CSCL) and Communities and Technologies (C&T) have begun to think about how small groups and communities-of-practice relate to computational infrastructures. Consideration of small groups brought in anthropologists and communication analysts. As we now expand to consider computer support for communities, social theorists and business management specialists also become involved in the multidisciplinary effort. Consideration of the community already includes the ultimate expansion to thinking about computers and the world. Groupware bleeds unnoticed into global applications: The burgeoning variety of Internet-based communication media—IM, email, wiki, blog—bring the world together into a maze of community. At this point, computer artifacts become pervasive infrastructure and social practices of usage, far outstripping the plans of technology designers.

Modern communities are learning communities in the sense that they evolve through the collective building of knowledge and the shifting participation of their members (Lave and Wenger 1991). Conversely, learning can be viewed in terms of a member's increasingly skilled participation in knowledge-based communities. The interplay of community members and the development of their participations are increasingly mediated by computers, networks, software, databases, websites, digital media, etc. The theme of computer support for learning communities is a timely and significant one.

The papers collected here not only recognize the irresistible potential of computer support for learning communities, but at the same time they delve into the ubiquitous barriers and social contradictions involved. They recognize that the design of community-based learning is not simply a matter of technological engineering, but integrally involves intransigent social issues. Existing community structures and educational institutions evolved to meet the needs of a bygone era; adapting them to a high-tech knowledge society confronts conflicts that would not even occur to armchair designers. To uncover and explore these realities of developing learning communities, each paper in this special issue (a) investigates a concrete real-world case and (b) subjects data from that case to scientific analysis. The results may not always be encouraging, but they are thought-provoking and important.

Learning about computing in the community. The first paper takes us out into the community, to a geographically-based nonprofit community organization. It asks how one can foster the kind of practical, technical learning within such an organization that it needs to achieve its goals today. The staffing of a nonprofit is not structured to support learning of its own participants, although its mission in the case study example depends upon educating the local population about ecological issues. In order to accomplish this mission, the organization must learn how to develop and maintain an effective Web site despite severe limitations on technical skills and financial resources. Issues of community computing under these conditions highlight a number of general problems and suggest some innovative responses for diversifying participation, managing organizational knowledge and enhancing social capital. The paper shows how carefully structuring technical training as participatory design can help the organization to learn in a sustainable way.

Re-engineering a learning community at school. Another study by the same group takes what they learned about the nonprofit Web site experience back into the public school. Just as the technical support experts learned from the community volunteers in a way that engaged and empowered the people in the organization, so the teachers in the school learned from their students in an interaction that benefited everyone. Students are often more technically facile than their teachers, so why not, argues this paper, let the students teach the teachers about technical matters. The experience results in authentic learning for the students and ties their learning to tangible practical ends that motivate engagement.

Implementing collaborative inquiry despite school. The kind of learning that builds inquiry skills is severely constrained by the social structure of conventional schooling, even in countries like Finland with successful, progressive education systems. The physical space and time of the school separates students and isolates teachers. It compartmentalizes learning into bite-size servings of unrelated disciplines. It divides lessons from testing—contradicting the formative role of assessment and focusing activity around a tyranny of grading. While this case study transformed some of those conditions, it still found that concerns about grading formed a major barrier to collaborative inquiry. Another, related problem was continued student orientation toward completing assigned work tasks, rather than pursuing progressive inquiry defined as the continuing improvement of knowledge objects (questions, ideas, explanations) within the learning community. Computer support can only facilitate knowledge building if the social relations and the epistemic orientation of teachers and students are already focused on pursuing collaborative inquiry.

Influences of student, group and task characteristics. A traditional mode of analysis within educational research is the statistical analysis of quantified independent variables upon dependent ones, such as exam scores and other operational indicators of learning outcomes. This paper illustrates a multilevel analysis that can distinguish effects of individual differences from effects of participation in small groups. Here, the “learning community” is a freshman college course of 230 students divided randomly into groups of 10. The “computer support” is a generic threaded discussion tool for each small group to communicate about assigned themes. Each student is required to post at least 2 messages to each theme within a 3 week period. A sophisticated statistical analysis is unable to find significant effects of this exercise on the learning within the small groups, despite all the literature that the authors cite on the benefits of CSCL. Perhaps the point is that it takes more than a vanilla communication medium and a minimal imposed interaction task among randomly collected students to constitute effective computer support or a consequential learning community.

Moderation strategies for learning communities. This study explores some techniques for building a more effective learning community through carefully designed computer support and skillful pedagogical facilitation. First, the small group of 12 college students was given an intensive two-month collaborative learning assignment. Second, they were given a sophisticated computer-based environment in which to work. While this software was also a threaded discussion system, it included extensive functionality to support and scaffold collaborative knowledge building, including tools for the students or for a moderator to link, highlight, annotate, manipulate and structure posted notes. The reported experiment is a unique attempt to investigate the applicability of small-group facilitation techniques to computer-supported threaded discussion. Interestingly, the designed functionality for moderation can be used by the students themselves as well as by an outside moderator.

Issues in building social capital in learning communities. The final paper takes the classroom back out into the community, into the reality outside of school walls. It tries to build an apprenticeship learning community consisting of future and current entrepreneurs. By building working relationships between a student community and an entrepreneurial community, it strives to increase trust and thereby build social capital as well as understanding. Although the students are university computer scientists, the computer support only plays a mundane role in the community building. The paper nicely details both the theory and detailed practicalities of trying to match two very culturally different communities, and evaluates the limited success. Perhaps this points to the moral of the special issue as a whole: that the complexities of the social issues dwarf the technical support issues, which however, still need to be respected.

In these six diverse papers we see a range of approaches to computer support for learning communities. Their contrasting experimental approaches and incompatible analytic methodologies illustrate major directions within this multidisciplinary field. The pros and cons of these alternatives are highlighted by the juxtaposition of the papers. Each paper presents its theoretical foundations and its scientific methodology, illustrating these with a concrete application. Despite sophistication of theory, complexity of method and extent of research effort, each study falls short of achieving desired learning and community outcomes. The papers not only present important findings; they also illustrate in their various shortcomings the abiding limitations of our current knowledge of this important question: how to provide adequate socio-technical support so that learning communities can achieve their manifest potential.

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Supporting community-based learning: Case study of a geographical community organization designing its web site

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Abstract. Community computing supports human-computer interaction among neighbours in geographical or place-based community organizations. Using a case study of such an organization, we investigate the process of designing their web site. Our long-term participatory design approach, integrating developmental informal learning, allowed us to understand how this community organization adopts, evaluates, and sustains web site technology. Based on our case study analysis, we present three design heuristics for developing community-based technology: align and afford new possibilities for participation; dynamically manage organizational knowledge and learning; and enhance social capital within community organizations and with the broader community.

Keywords: Community computing, long-term participatory design, developmental informal learning, sustainability.

1. Introduction

As the Internet becomes more embedded in our daily lives, it is critical for community organizations to have a web presence to disseminate information effectively and efficiently to public citizens, discuss issues related to regional economic development and social services, and most importantly, be able to connect and stay connected with the larger geographical community. In this paper, we report a case study of a local community organization, Spring Creek Watershed Community (Spring Creek), designing their web site to achieve such goals. In working with Spring Creek, we followed a participatory design approach in which we qualified our role as facilitators and technology consultants in the design process rather than technology providers or programmers. Through such roles, a fabric of informal learning was introduced in which members of Spring Creek analyzed, designed, and managed their web site in the long-term.

Community-based learning can refer to a variety of forms of learning, both formal and informal, in the context of individuals, groups, and communities (see discussion in Stahl 2003). We are interested in informal learning in the context of community computing. Although learning is closely associated with schools and classes, most of the learning in our lives actually takes place outside the control and confines of formal education (Brookfield 1984; Caffarella and O'Donnell 1987). Informal learning is manifested in our daily, meaningful activities in the context of our home, work, social life, and community-based outreach. It occurs continuously throughout life, requiring no particular preparation (Dewey 1966).

From our interaction with Spring Creek, we learned how a community organization adopts, evaluates, and sustains Web site technology. Our contribution is the case study analysis, based on which we propose three design heuristics for developing Web site technology. These heuristics present possible socio-technical design interventions that consider the unique characteristics of geographical community organizations, such as their lack of resources of all sorts (e.g. money, technical skills, technology infrastructure). Our paper is also an empirical contribution to the study of community-based learning because it addresses geographical or place-based community organizations instead of online communities (e.g. community networks), communities of practice (e.g. community for teacher professional development), or educational communities (e.g. school settings).

This paper is organized as follows. Section 2 reviews related literature pertinent to the design context of community organizations. Section 3 describes our participatory design approach to work with community organizations to collaboratively design technology. Our premise is that engaging community organizations in more meaningful and long-term design activities will enable them to become a part of everyday information technology literacy. Section 4 gives a background of our case study and describes the research methods. Section 5 provides details of the case study and its analysis. In section 6, we present three heuristics for designing Web site technology based on our analysis of the case study. We provide some concluding remarks in section 7.

2. Literature review: Design context for community organizations

Community computing supports human-computer interaction among neighbours (Carroll 2001). It refers to socio-technical interventions to support community interactions and civic activities among participants living in physical proximity and sharing common resources. Examples of such geographical or place-based community organizations are a local food bank providing emergency food and clothing to those in need or an animal rights group protecting rare birds from extinction near an excavated site.

Community computing settings are viewed as a distinct domain containing activities and practices that differ from workplace and educational settings. While there is certainly overlap between these domains, the impetus is to discover the ways that community context impacts user requirements, system design, and socio-technical practices. Within the Human Computer Interaction (HCI) and Computer-Supported Cooperative Work (CSCW) communities, there have been a number of attempts to organize researchers around the community computing research area, including several workshops (ECSCW, 1997, Community Networks: Opening a New Research Field for Cooperative Work; ECSCW 1999, Broadening Our Understanding: Community Networks and Other Forms of Computer Supported Community Work; CSCW 1998/PDC 1998, Designing Across Borders: The Community Design of Community Networks), conferences (Communities and Technologies Conferences 2004 and 2005; Global Community Networking: Building an Internet for Citizens, 2000; Global Community Networking II: World Congress of

Citizens' Networks: Renewing Communities in the Digital Era, 2001), special issues of journals (Computer Supported Cooperative Work 7, 3/4), and the development of a new journal devoted to community computing (Community Informatics journal).

While there have been calls to study community computing contexts, there are few studies that attempt to describe how geographical community organizations appropriate technology. We are concerned with finding ways to support technology use, design, and learning in community organizations as they work to achieve social and communitarian goals. Technology plays an important role in community organizations, enabling them to advertise services, communicate their mission, and to recruit volunteers. Despite this importance, community organizations often face significant challenges when implementing technology in their organization (Balka 1997; Balka 1995; Benston 1990; McPhail *et al.* 1998; Trigg 2000; Mogensen and Shapiro 1998; Robertson 1998). In community organizations, technology decisions are often driven by the availability of scarce resources including few full-time staff members, limited (or nonexistent) technology budgets, little grant funding, and a constrained pool of technically skilled volunteers. Community organizations often make use of off-the-shelf solutions and have to live with a system even if it is not optimal because of the trade-offs involved in trying out a new system.

A number of strategies have been suggested to effectively carry out technology design projects in community computing. Kyng (1988) suggested a number of strategies that can be used with resource poor groups such as: (a) sharing stories and conducting work place visits to demonstrate how technology might be used in an organization, (b) finding models for local work, (c) using futures workshops to help people envision and plan for potential changes in work practice, and (d) and using mock-ups that make design decisions more concrete. These strategies are exemplified by a number of studies within CSCW that describe technology projects with nonprofits. Trigg (2000), for example, created a database that served as an in-house 'sandbox' to try out design ideas for a nonprofit. Robertson (1998) served in an advisory capacity helping an organization think through some of the "shopping' decisions involved in choosing a new technical system. Mogensen and Shapiro (1998) worked with groups to expand their technology thinking by presenting alternatives to solve problems that organizational members encountered in their everyday work. McPhail *et al.* (1998) used a future's workshop and demos to elicit user participation.

In our work, we try to push the line between user and designer further by finding ways of encouraging the development of design and technology planning expertise within the work practice of community organizations. The next section explores our methodological approach for working with community organizations.

3. Methodological approach: Integrating learning with long-term participatory design

Participatory design (PD), which originally emerged from socio-technical systems theory (Mumford, 1983), is a practice among design professionals that explores conditions for user participation in the design and introduction of computer-based systems in organizations (for detailed discussion, see Clement and van den Besselaar 1993; Greenbaum and Kyng 1991; Kensing and Blomberg 1998; Schuler and Namioka 1993). Concurrent with designing technology that facilitates communitarian goals, we are also interested in community organizations learning about technology and changing or refining their practices to sustain their learning over time.

Much literature on PD emphasizes that mutual learning by developers and users is an outcome of successful partnerships (e.g. Ehn and Kyng 1991). Carmel and colleagues (1993) mention that one of the themes in PD is mutual learning (Floyd *et al.* 1989), in which users and designers teach one another about work practices and technical possibilities through 'joint experiences' (Clement and van den Besselaar 1993; Kyng 1991). It has been acknowledged that mutual learning is not a separate activity but an inherent characteristic of the design activities in PD (Irestig *et al.* 2004).

Whereas PD researchers generally maintain consensus that learning is a part of PD, it is less clear what the nature of learning is during the design process. Traditionally, PD brings users and designers together in mutual commitment, where the users must learn about technology in order to understand what computer technology can do for them, and designers have to learn about the application domain in order to build a flexible and efficient system to fit the users' needs (Bjerknes 1993). Such views of learning in PD, Carroll and colleagues argue (2002), are quite singular and ephemeral. Rather, a 'developmental' view—in the sense of Piaget and Inhelder (1969) and Vygotsky (1978)—of learning should be adopted in which users develop qualitatively different roles through the course of long-term collaborative design process with designers. In the study by Carroll and colleagues, teachers went through transitory roles from being informants to analysts, designers, and eventually coaches. This developmental process was engendered by active contributions on part of the users and designers in co-constructing and engaging in meaningful activities. Other arguments for the developmental perspective of PD have also been made (e.g. Beguin 2003; Bodker and Gronboek 1996; Bodker 1999).

In considering learning in PD from a developmental perspective, the issue of sustainability becomes critical (Kensing and Blomberg 1998). Clement and van den Besselar (1993) note that when designers leave, the participatory processes seldom diffuse to other organizational entities. They argue that users must increasingly gain in their ability and willingness to take on the roles of designers. PD projects are increasingly developing knowledge management strategies and techniques to help sustain the participatory process after designers depart or fade (e.g. Bodker 1996; Kensing *et al.* 1998).

Our approach to PD incorporates developmental and informal learning as argued above. We take a long-term PD approach that combines ethnographic fieldwork with participatory design to develop community-based technology (Carroll *et al.* 2000). Learning is inherent in our approach, where community members are engaged in self-directed and relevant design activities, gaining in their capacity to become more technology skilled through hierarchical and lateral forms of learning (Farooq *et al.* 2005).

At the same time, we as designers explore different roles such as facilitators and technology consultants in the design process to support their learning cause (Carroll 2004). Our PD approach is guided by the goal to achieve sustainability (Merkel *et al.* 2005; Carroll and Farooq 2005). We work to achieve sustainable design, learning, and work practices that inject a sense of designer independence on part of the community organizations as we fade from the process.

4. Case background and research methods

Our case study is part of the Civic Nexus community computing project. Civic Nexus is a three-year participatory design project with the goal of working with local community organizations in Centre County, Pennsylvania (USA) to increase their ability to solve local community problems by leveraging and enhancing their capacity to use information technology (Merkel *et al.* 2004). Each year, we work intensively with a cohort of four community organizations. We begin with ethnographic fieldwork to understand how technology is used in an organization and how it fits with their values and work practices. We then work with the organization to select a technology project that we will work on together over the course of approximately a year. During the concluding stages of the technology project, we gradually fade from the process in an effort to allow the community organization to manage and guide their technology endeavours.

Spring Creek was one of the organizations we focused on during the first year of the project (2003-2004). Following is a brief description of the organization.

4.1. Background: Spring Creek Watershed Community (Spring Creek)

Spring Creek (http://www.springcreekwatershed.org) is a community organization located in State College, Pennsylvania (USA). The mission of Spring Creek is to promote actions that protect and enhance the quality of life, environment, and the economy throughout the watershed while maintaining and improving the high quality of Spring Creek and its tributaries. Their Web site is a way to achieve their strategic goals of increasing public awareness of watershed issues through education and communication, enhancing intergovernmental and interorganizational cooperation, and maximizing involvement and participation in Spring Creek actions.

Spring Creek was born in 1997 through a grant by Pennsylvania's Department of Environmental Protection to Clearwater Conservancy, a stakeholder group of Spring Creek. The fourteen Spring Creek Watershed municipalities recognized the importance of sharing watershed challenges and concerns with each other and came together voluntarily to form the Spring Creek Watershed Commission. Elected or appointed officials from these municipalities gather every other month to discuss watershed issues and promote watershed cooperation. They jointly sponsored several important projects, the most notable being the development of a Spring Creek Watershed Plan. This integrated water resources management framework coordinated projects of stakeholders throughout the Spring Creek Watershed Community, including not only the municipal partners and authorities but also nonprofit organizations, educational institutions, the development community, and private citizens.

Watershed planning is a challenge because the units of government charged with land use planning are different than the geographic units defining natural resources. But with increasing awareness of water resource and other ecological systems and their fragile nature, cooperative planning and decision-making among Pennsylvania municipalities will become not only more accepted but increasingly promoted as the most logical method to manage water resources and ensure their protection for the health, safety, and welfare of the citizens of Pennsylvania.

Like most community nonprofits (Benston 1990), Spring Creek has limited staffing and financial resources. Table 1 lists the key players in Spring Creek with whom we interacted with.

Spring Creek has only one paid staff member, who works for Clearwater Conservancy. This staff member, Lauren, is compensated by Clearwater Conservancy for dedicating 15% of her time to Spring Creek in the capacity of its lead coordinator. Emily was a full-time staff member for Clearwater Conservancy. Her role was to lead the Water Resources Monitoring Project, started by Spring Creek to establish baseline data to be used for longer-term protection of Spring Creek and its tributaries. Financial support for the monitoring project came from a variety of watershed stakeholders including industries, institutions, municipalities, authorities, and foundations. Andy was an undergraduate student at a large university in Centre County. As a student, he was required to complete an internship as part of his program requirements, which he took up through a volunteering position with Spring Creek. Richard was a volunteer for Spring Creek and Clearwater Conservancy, with an interest in enhancing the technology capacity of Spring Creek. The volunteers were not financially compensated.

Table 1. Key players in Spring Creek.

Name	Role	Background
Lauren	Lead coordinator for Spring Creek	Limited technical background, trained in nonprofit management
Emily	Staff member for Clearwater Conservancy working on Spring Creek's web site	Limited technical background, trained as biologist
Andy	Volunteer intern from university for Spring Creek	Technically proficient, trained in computer science
Richard	Volunteer for Spring Creek and Clearwater Conservancy	Technically proficient in Web technologies and databases

4.2. Methods

4.2.1 Data collection. Research access was granted in October 2003 during a workshop in which we invited potential community organizations to partner with us on the Civic Nexus project. Spring Creek expressed their interest in working with us. The field research was carried out during a period of approximately 14 months up to November 2004. Although our direct involvement faded after this time, we continue to monitor the progress of Spring Creek with respect to their web site technology.

Because our methodological approach was guided by participatory design, the primary method of data collection was observation recorded through field notes. However, observations were not just passive. We assumed a variety of roles within the case study situation and participated in the events being studied in the capacity of different roles (Yin 2003, pp. 93-94). Our research method more closely resembled action research. We attended Spring Creek's Web site committee and other technology-related meetings, each lasting about an hour. During observation, we assumed active roles such as facilitators and technology consultants, consistent with our participatory design approach. We also made direct observations during which we adopted slightly more passive roles, such that we were observing activities and their dynamics but not taking part in them. Secondary sources of data collection included documentation (e.g. meeting agendas, meeting minutes, and newsletters), archival records (e.g. emails and web sites), and physical artifacts (e.g. design mock-ups and scenarios).

We conducted two semi-structured interviews with Lauren and one with Emily that lasted approximately an hour each. We focused on Lauren and Emily because they were the primary stakeholders of Spring Creek and were non-volunteer members of the organization (paid staff members or in charge of the decision making process). The interviews were tailored to each person and focused on their perception of what happened and why in relation to Spring Creek's Web site; on how decisions and actions were influenced and made and conflicts resolved; and on our particular role. The interviews were tape-recorded and subsequently transcribed. Additionally, many informal discussions, including both face-to-face interactions and phone conversations, were held with Lauren and Emily.

4.2.2 Data Analysis. The analysis of the data collected was done using the general analytic strategy of developing a case description (Yin 2003). Although the objective of the study was not a descriptive one, a descriptive approach was followed to help identify the complex stages of designing a Web site and how we as researchers scaffolded this process using the participatory design approach summarized in section 3. Our perspective on participatory design as a learning process guided our analysis of the data, reflecting important socio-technical elements of designing a Web site. However, the data were also used to inform the participatory design approach itself, in that the design emerged as an iterative process taking place throughout the data collection and analysis phases. For example, the idea of ceding ownership was developed at a fairly later stage after analyzing Spring Creek's insistence on us designing their web site, and seeing the importance of sustainability in community settings.

4.2.3 Data Evaluation. In order to assure rigor of our results, we triangulated the multiple sources of data collection. To ensure reliability and plausibility of our results, all of our field researchers met biweekly with others in the Civic Nexus research group to report the field observations. The research group reflected on the collected data to generate collaborative interpretations. This collaborative process of data analysis helped to remove the individual researcher's subjective bias, thus increasing the reliability of data analysis.

We worked hard to achieve investigator triangulation. Multiple researchers from Civic Nexus attended meetings to converge on the interpretations that were being made about Spring Creek's Web site design process. The reporting of the experience with Spring Creek in this paper is from the researchers' perspective of the dynamics that occurred within Spring Creek during their Web site design process. Member checking was performed in our research, where we presented our analysis for feedback from Spring Creek, accounting for our bias in interpretation of the community context and the process of Web site design.

A research issue we encountered was anonymity. We have used the actual name of our case study organization, because we feel that knowing information about their Web site, specifically the URL and back end system, is critical to understanding the issues that revolve around designing a Web site. However, we have anonymized the names of Spring Creek's key players to protect their real identities.

Because of the particular methodological perspective we adopted in our fieldwork, another critical research issue we faced was the difficulty in trying to encourage change and observe change simultaneously. It would often happen that we would be actively engaged in solving a problem with the organizational members (e.g. helping them understand how to upload files to a web server), which would render it difficult to take field notes related to that particular situation. In such cases, we often tape-recorded meetings for later reflection and analysis, and had multiple researchers in the field for different tasks (e.g. one researcher engaged in problem solving and the other taking field notes).

Our methodological approach of long-term participatory design obviously has several challenges. These challenges are discussed in our prior work (Merkel *et al.* 2004). For example, our role as researchers co-evolved with emerging practices of the community organization. In some cases, we adopted more passive roles where we simply observe community settings, and in other instances, we adopted more active roles where we co-construct joint activities with our community partners. As such, it became difficult at times to gauge the level of our influence on community practices. We regularly teased out such influences in our research meetings and through member checking, as mentioned before.

5. Case description and analysis

This section contains the description and analysis of the case study. The first subsection is a prelude, since it provides an overview of the events from October 2003 to November

2004. The remaining three subsections analyze the process of adopting, evaluating, and sustaining Web site technology by Spring Creek. Specifically, these sections address the use of content management systems to develop and maintain web sites.

Prior to Spring Creek's use of content management systems, other significant events took place related to the design of their Web site. For example, Spring Creek first tried to understand what 'design' meant and subsequently analyzed their Web site to elicit design requirements. In another instance, Spring Creek used techniques like scenarios to design the content and layout of their Web site. We mention such events in the overview to give readers a background, but we do not analyze them because our prior accounts have already done so (see Farooq *et al.* 2005; Farooq *et al.* 2006). Moreover, analysis of Spring Creek's Web site technology, which we focus on, is more relevant to this special issue.

5.1. Overview of events

Prior to our involvement, Spring Creek's Web site was developed and maintained by a commercial vendor. Spring Creek's goals on the Web site were misaligned with their actual mission. The vendor projected them as a stereotypical environmental preservation group, whereas they sought to express their actual goals: local economic planning, influencing decision makers, and encouraging quality of life through watersheds. The situation was even more frustrating for Spring Creek because they did not have control of their Web site. They did not have administrative rights to their Web site nor were they technically skilled enough to update the Web site themselves; furthermore, the vendor was not willing to update the Web site as per Spring Creek's requests.

Spring Creek decided to take control of their Web site. During October 2003, Lauren formed a Web site committee for Spring Creek. In November 2003, the first Web site committee meeting was held, led by Lauren, and attended by many volunteers interested in working on Spring Creek's Web site. During this meeting, Lauren explained the need to redesign Spring Creek's Web site. This meeting provided the foundation for seven subsequent Web site committee meetings. Table 2 gives a summary of all these meetings.

Table 2. Summary of web site committee meetings.

Meeting (date)	Meeting agenda
Meeting 1 (November 1, 2003)	Introduction of committee members; Lauren explains purpose of forming committee.
Meeting 2 (November 15, 2003)	Discussion of possible hosting services for Web site.
Meeting 3 (December 13, 2003)	Web site host decided; Lauren to collect Web site content; Andy, intern for developing online newsletter, introduced to the committee.
Meeting 4 (February 7, 2004)	Review of mission statement; committee focuses on developing

	Web site content.
Meeting 5 (February 21, 2004)	Negotiation between designing content versus layout; Andy's email regarding newsletter WYSIWYG editor.
Meeting 6 (March 6, 2004)	Identification of three audiences for Web site; Civic Nexus researchers suggest using scenarios for designing layout.
Meeting 7 (March 20, 2004)	Compared and contrasted other Web sites resembling Spring Creek's mission; layout of front page discussed.
Meeting 8 (April 3, 2004)	Lauren reads her scenario to design front page; design of front page begins using paper mockups; discussion of using wiki to prototype Web site.

During the second and third meetings, among many events and actions that took place, two of them stand out. First, Lauren was supposed to draft the content of the new Web site. This involved redoing Spring Creek's mission statement and their core message that they wanted to convey to their stakeholders through their Web site. Second, outside of the Web site committee meetings, Lauren recruited a new volunteer intern, Andy, to help with peripheral tasks related to Spring Creek's Web site. Specifically, Andy's responsibility as directed by Lauren was to develop Spring Creek's online newsletter to be put on their Web site. Following is an email excerpt on December 30 2003 by Lauren to the Web site committee, updating them on the progress so far (words in bold henceforth are our emphasis).

> Result: Umer, Richard, and I ended up meeting for a little while on December 13.
>
> What happened:
>
> 1) We outlined how I was going to leave our current host and then switch to our new host.
>
> 2) We finalized the draft mission statement.
>
> 3) I was assigned the task of compiling the first batch of content.
>
> 4) We agreed on assignments for Andy (our new intern) - create a proposal for the newsletter
>
> 5) We agreed that the committee should meet in January.

During the fourth and fifth Web site committee meetings in February 2004, the content of Spring Creek's Web site started to emerge. Many discussions were held between the committee members, specifically related to the confusion between the concepts of designing for content and designing for layout. The outcome of these discussions was that content of the Web site should be designed first, focusing on the core message of Spring Creek. Layout was to be designed once the content was finalized.

At the end of the fifth meeting on February 21 2004, Lauren forwarded an email from Andy to the Web site committee regarding the design of the newsletter. Lauren wanted feedback from the committee on Andy's newsletter proposal (referred to as 'document' in the email). Following is the email excerpt from Andy to Lauren.

> Been working on the external design for the newsletter. Ran into a few things I'd like to get your feedback on before I proceed.
>
> Could you email me the updated mission statement for the website as I'd like to incorporate that into the document…I just want to make sure that the document meets your goals.
>
> Also, take a look at browser based WYSIWYG ('What You See Is What You Get') editor link below…
>
> I am interested in your thoughts regarding the usability of the WYSIWYG…

The newsletter proposal was quite comprehensive, detailing requirements specifications and Andy's responsibilities over the next few months. The objective of the 13-page proposal was the following (taken from proposal): 'The purpose of this document is to provide the system overview and specifications and present the baseline requirements for newsletter development'. The proposal was divided into four sections: Section 1—Overview of the project; Section 2—Functions and framework of the newsletter application; Section 3—Detailed look at newsletter publishing cycle (creation, publication, modification); Section 4—Project timeline.

In parallel with Andy's work on the newsletter proposal, three Web site committee meetings were held in March and April. The result of these meetings was that the Web site content was finalized, and the layout was being discussed. Various paper mockups were presented as alternatives in the eighth meeting.

We (the Civic Nexus researchers) suggested the use of wikis—online WYSIWYG editors for editing Web pages without knowing much programming—to model the paper mockups so that Spring Creek could see the consequence of implementing them through prototypes. We did not want to overlap with Andy's work on the newsletter design, as he was also using a WYSIWYG editor, similar to a wiki. After discussing this situation with Lauren, it was decided that it is better to ask whether or not this would be an issue. Following is an email reply from Andy to us on April 6 2004.

> No I am not working on the design (of the web site). Feel free to model it as you wish. If you'd like some feedback, send the layouts out to me.

Following this email, we created three different templates for Spring Creek's Web site on our system known as BRIDGE (Basic Resources for Integrated Distributed Group

Environments; http://bridgetools.sourceforge.net) (Ganoe *et al.* 2004). The BRIDGE infrastructure is seamlessly integrated with browser-based wiki-style asynchronous editing. For accessibility and familiarity, BRIDGE client systems look and behave like a normal web site, with all content rendered as HTML and images. Simple forms of authoring are supported. Each page has an 'Edit' link which supports editing and new page creation using a simple shorthand notation that requires no external authoring tools or knowledge of HTML.

At the end of April, we emailed these Web site prototypes to Lauren. In early June, we met Lauren and explained how to use the system to edit the web pages, add menu items, create links, and so forth. Lauren preferred the third web site template we developed (http://java.cs.vt.edu/public/users/ufarooq/Spring+Creek/Sample3/index.html).

We had only created a few menu items and links on this Web site so as to provide a minimally detailed and basic template for Spring Creek to start adding richer content. Lauren and Emily, a newly hired staff member, started adding content during June, July, and August 2004. They designed the logo, added hyperlinks to the Web site, contributed significant content (e.g. historic timeline of Spring Creek, details of the Water Resources Monitoring Project), and much more. We also met with Spring Creek in early August to better understand their use of our system and gauge requirements for enhancing BRIDGE to further support their activities.

Because the Web site was nearing completion, Lauren wanted an update from Andy regarding the newsletter so it could be uploaded to their Web site on BRIDGE. She sent the following email to Andy on August 12 2004.

> Here is the link to our 'final draft' of our website…As far as the site design goes, I would say it is done and that you can use this style to finish the newsletter…We are planning on going live with it in early September after the newsletter is done.

On August 14 2004, Lauren got a response from Andy, in which he had redesigned their whole Web site. Following is the email reply from Andy:

> With time running out I decided to make the whole effort worthwhile. I've configured and modified an open source content management system to suit your needs. Not just for newsletters but the entire website.

This 'surprised' Lauren, as was indicated in one of our transcribed phone conversations with her and Emily on August 18, 2004:

> 'My understanding is that he was done with his internship at the end of August period. And so when he sent me those emails (referring to Andy's emails), I was really surprised because he was telling me that he was really busy'.

Spring Creek now had to make a decision between BRIDGE, which had already been used to create significant content during the summer (June-August 2004) by Lauren and Emily, and Andy's open-source content management system Mambo (http://www.mamboserver.com). Mambo, like BRIDGE, allowed management of Web sites by any administrator or authorized user. Only the super-administrator and administrator needs a high level of technical knowledge in Mambo; the manager, user, and guest use a WYSIWYG editor to interact with the web site.

Following our participatory design approach, we did not want to make the decision for Spring Creek. Rather, we wanted to help them discover the pros and cons of both systems and eventually resolve the situation on their own.

We subsequently met with Andy, Emily, and Lauren in September 2004 so that Andy could explain the functionalities of his system. During this meeting, we provoked questions on behalf of Spring Creek such as how easy it would be to update a Web page or upload a picture. The outcome of this meeting was exploratory. Lauren and Emily decided to give Andy's system a try, and thereafter emailed him asking specific questions on using Mambo. During October, Lauren and Emily met with us and specifically asked us what Spring Creek should do to decide between BRIDGE and Mambo. We remained resolute, using the utmost care so as not to bias them toward any one system and encouraged them to think about the consequences of using BRIDGE and Mambo. For example, we asked them to consider how Spring Creek will maintain BRIDGE and Mambo after we fade from the research setting and Andy moves on.

After this meeting, Spring Creek decided to develop their Web site with Mambo. The content from BRIDGE was ported to Mambo and further refinement was done. We interviewed Lauren and Emily individually during November to understand their rationale for choosing Mambo over BRIDGE and their decision-making process. This allowed us to compare socio-technical elements of two content management systems and glean in-depth requirements for designing Web site technology for community organizations.

Spring Creek's current Web site is using Mambo's content management system (http://www.springcreekwatershed.org). Lauren and Emily, among others in Spring Creek, now manage the Web site in-house by themselves without relying on any specific technical volunteer. The decision making they had to do required and motivated learning and the development of critical information technology skills—which is probably more important and significant than the decision itself.

We now analyze our data regarding Spring Creek's adoption of BRIDGE, evaluation of BRIDGE and Mambo, and maintenance of their current Web site.

5.2. Adoption of content management system

Content management systems, like BRIDGE and Mambo, are end user development tools. End user development is about exercising greater control by non-developers and non-programmers over technology, such as enabling design of computer-based applications without getting entangled in the nitty-gritty details of programming (Sutcliffe and Mehandjiev 2004). Our rationale for introducing BRIDGE to Spring Creek was to enable members, like Lauren, to become an integral part of designing their Web site so as to emphasize their organizational values as it related to their organization's mission (Farooq 2005). One of the tensions we had in mind was that members of community organizations rely on help from volunteers and have a strong tendency to want experts to use technology (Benston 1990). This is because they have little time to devote to technology as indicated by the following quote from an interview with Lauren:

> 'This isn't a funded project; I'm basically volunteering my time…We don't have time to learn this (referring to technology)'.

One reason BRIDGE was used extensively to design Spring Creek's Web site was the minimal cognitive overhead needed for its use. Furthermore, the benefits of using a wiki-like system were apparent, as it required little learning and less time to achieve tangible results. Although we realized the benefits of BRIDGE for Spring Creek, we did not impose technology on them but allowed them to assess how it fits with their organizational practices (Trigg 2000). At the time when we introduced BRIDGE to Lauren, she was extremely enthusiastic about using it and remarked:

> 'This (referring to the wiki-like functionality) is just motivating me…you're putting something in front of me that I can use'.

After becoming somewhat familiar with BRIDGE, Lauren indicated her desire to leverage volunteers to manage the Web site:

> 'What I would like to do eventually is once we get the site in a manageable point, I would like to have a volunteer or two volunteers who are willing to update the site regularly'.

However, relying on volunteers carries its own baggage of problems. For example, in one of the interviews, Lauren from Spring Creek remarked about volunteers who might not fully understand their mission in their limited participative time, and how this might have adverse effects on their organization:

> 'Like there's this one volunteer who I would like to be able to have him do certain things on the site, **but I don't trust him**…If he only had control over that one thing so he's not promoting his own agenda, that would be good…**You don't want somebody to be able to go in and screw up your site'**.

In June 2004, Lauren involved Emily in starting to add content to their BRIDGE Web site. At this point, before Emily could even add content, it was problematic for her to login using BRIDGE as indicated by one of her emails to us:

> 'Lauren gave me a list of things to add to the Website (she left for the day) and I cannot seem to log on to the site with her name and password. Do you know what her password is? (I can tell you what she told me it was)'.

Even though coordination to some extent was done between Lauren and Emily, helping Emily to start using technology took some effort. Part of this was because of the diverse skill set of community organization members—Emily was not familiar with Web site technology. After creating a user name and password for Emily, her reply to us was:

> 'Thanks! I am new to the world of Web sites so I am sure that you will be hearing from me soon'.

Indeed, we did. We facilitated Emily in adding content to Spring Creek's Web site. Some activities that Emily learned during the course of using BRIDGE were linking Web pages, adding hyperlinks, and creating menu items.

5.3. Evaluation of two content management systems

The months of August, September, and October 2004 were challenging for Spring Creek. After a surprising email from Andy redoing the whole of Spring Creek's Web site, Lauren and Emily had to decide between BRIDGE and Mambo. The 'look and feel' of Spring Creek's Web site on Mambo was similar to the one on BRIDGE, because Andy had simply imported the content (see Figures 1a and 1b).

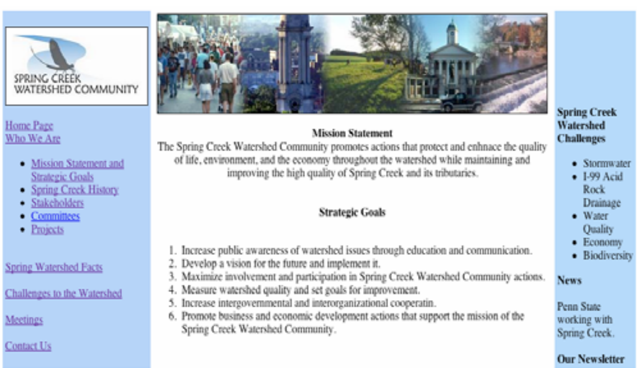

Figure 1a. Spring Creek's front page on BRIDGE.

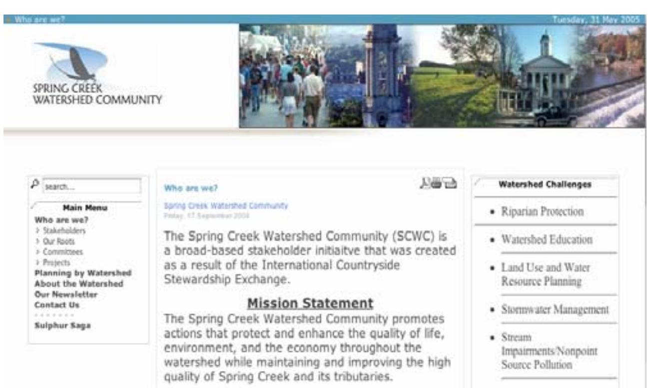

Figure 1b. Spring Creek's front page on Mambo.

The tension for Spring Creek in making their decision was related to the learning and effort that Lauren and Emily underwent over a few months to acclimatize to BRIDGE. In a later interview with Emily during November 2004, she reflected on this:

> 'At first, neither of us (Emily and Lauren) wanted to switch…I was very reluctant because I had been the one that put up most of the content on the Web site'.

Further, Lauren perceived Andy's effort as futile to some extent because Spring Creek was so close to going 'live' with their BRIDGE Web site in September 2004. During our phone conversation on August 18, 2004, Lauren remarked:

> 'It sounds like to me what he (Andy) just did is a big duplication of effort. I saw this stuff on Sunday (referring to Andy's emails) and I was kind of upset because I kind of felt like we were headed down a successful road and…this now a fork…I just feel like we are so close to being live in September and this just seems huge'.

During our interaction with Spring Creek, we noticed the tension between valuing volunteer participation, specifically Andy's work with Mambo, and choosing BRIDGE. In an informal phone conversation we had during first week of September 2004, Lauren addressed her concern that if she goes with Andy's system, would we 'have any bad feelings' in working with Spring Creek. We clearly expressed our position, stating that we would facilitate Spring Creek irrespective of their decision under the rubric of our Civic Nexus research project. To this, Lauren responded, 'I appreciate this'.

Sustainability was Spring Creek's primary concern during their decision-making process. They had already experienced a lack of control over their technology (Web site) with the previous vendor, and did not want to be left in the same position. In our August 18, 2004 phone conversation, Lauren expressed this concern:

> 'I think that we're capable of using either system from first glance. I mean it's way better than it ever was (referring to the situation of having a choice between two systems)…but again, I didn't try his (Andy's) system…so that's one thing. The second thing…my big concern is…**am I gonna end up in the same situation** (referring to their previous Web site and being dependent on a vendor) because is he (Andy) gonna be there for support'.

Functionally, BRIDGE and Mambo are quite similar; they both support WYSIWYG Web page editing, accounts management, and file management among other features. The major difference between BRIDGE and Mambo was that at the time, BRIDGE was not released as an open-source system, whereas many users already embraced Mambo in the open-source community. We were clear about this matter with Spring Creek, explaining to them how the use of an open-source system is one facet of achieving sustainability because of the wide user base and helpful online resources like forums. Being reasonably comfortable with the idea of seeking future help from an open-source community at this point, we and Andy met with Spring Creek in September 2004 to experiment with Mambo and assess its usability. Prior to this, Andy had not met with Spring Creek to explain Mambo's functionality. Lauren was concerned with the 'ability to change stuff on our own (referring to Spring Creek)'. Emily, who had significantly developed content in BRIDGE, was proactive in asking Andy about Mambo's features:

> 'Could you explain just like the hierarchy of this system like a category versus an item versus what's a section…I think (be)cause that would help me figure out how I need to put things in there (referring to adding content and structuring the Web site directories)'.

After this meeting, Spring Creek adopted Mambo as their Web site content management system. In a later interview with Lauren in November 2004, we asked her to reflect on her decision making process between BRIDGE and Mambo. She, in fact, preferred BRIDGE to Mambo in terms of usability, but felt that Mambo was more sustainable in the long-term, as indicated by her response:

> 'Aesthetically, I liked yours better (referring to BRIDGE in comparison with Mambo)…it was really hard (referring to the decision) because I liked the way yours looked better. When you look at the management of files **over time, I felt like that (referring to Mambo) was probably going to be easiest**…I don't even know if it was a good decision…Even though its not really what I probably want to do, because its easier to stay with this one (referring to BRIDGE), but **long-term…I hope we made the right decision (going with Mambo)'**.

Spring Creek quickly learned Mambo, its administrative functionalities, and Web site management capabilities. From September-November 2004, Emily and Lauren actively used Mambo to develop their Web site, importing much content and layout information from BRIDGE. It was clear that Spring Creek had now decided to go with Mambo as their community-based technology.

5.4. Maintenance of Web site

After we met with Spring Creek and Andy in September 2004, to date no one has heard from him again, despite Lauren's multiple attempts to contact him via email and phone. From our perspective, this was similar to Spring Creek's earlier situation when the vendor created their Web site but never maintained it. However, this time, Spring Creek had control of their technology. In a matter of weeks, after this meeting with Andy, Emily was actively using Mambo forums to help herself learn the ropes of Spring Creek's newly adopted community-based technology. When asked in an interview in November 2004 about how she learned Mambo and what kind of resources she used, Emily replied:

> 'I rely heavily on the Mambo forums. I love forums because you're anonymous…The Mambo forums have been great. I have been printing out everything they send me'.

To us, this was an indication of at least two things. First, leveraging forums was a way for Emily and potentially other Spring Creek members to bridge social capital with Mambo's online open-source community. Second, Emily felt more confident in using and learning Mambo as she received friendly and encouraging responses to her questions on the forums. For example, she related an experience in which one of the forum responders read Emily's profile as a biologist and encouraged her in a subtle manner:

> 'I signed in…as a biologist trying to make a Web site…he (forum responder) said something about "**I'd rather you be a biologist trying to make a Web site than a Web site designer trying to clone a sheep"** (laughter all around during the interview)'.

We were also interested in how Spring Creek was, or was going to manage knowledge for the purpose of transferring their newly learned skills to other members. This was important because in community organizations, the primary source of the workforce is volunteerism, which typically implies short-term, ephemeral interjections. Thus, it becomes important to quickly train newcomers. Prior to interviewing Emily, we interviewed Lauren in November 2004, and we asked her about any documentation they maintain, to which Lauren responded:

> 'I just gave Emily my folder on the Web site. I have a folder that has, you know, the committee information, our URL, the server like (information)…(Lauren gets the folder to show the Civic Nexus researcher)…the idea was just to try to get everything so its in one place. So I had all the hosting stuff…**I have been building this so I have everything in one spot**…Eventually, all the Mambo stuff will be in here'.

We decided to probe this further by asking Emily how this documentation could be used. She commented:

> 'If somebody were to come in after me, if I were to leave, it would be easy for me to help them learn this site…I think if we keep documenting the way we do, it will be alright'.

Emily also gave an example of training existing staff members to learn Mambo:

> 'We are talking about our office manager…so after we have everything setup, we will show him how to add content…It would also be in Clearwater that everybody would be updating I think'.

After conducting these interviews in November 2004, we gradually faded from the process. We did not meet face-to-face with Spring Creek, though we exchanged a few emails with them since then (approximately ten emails to date), responding to some of Emily's technical questions and occasionally asking them about the status of their Web site. In February 2005, Lauren emailed us about their current status and future plans:

> Good news - We recruited a volunteer who is working with other volunteers to create some of the more substantial content. It will take a while for this content to be completed start to finish because they are volunteers, but they are very excited about the new site and have said that it is a big improvement…
>
> You guys really did a great job and I can't wait for more content to be added to the site.

Based on our data analysis, in the following section we discuss implications for designing Web site technology. The following points summarize the case study:

- Community organizations value their mission and care about how the larger geographical community perceives them. Misalignment of their projected, online goals with their actual mission motivated and seriously committed Spring Creek to modify its learning and work practices, and move toward revamping their technology practices for the collective benefit of their organization and the larger community.
- Community organizations value participation, specifically volunteerism that often comprises diverse (in background, skill set, and so forth) and ephemeral constituents. In our case study, managing these constituencies for Lauren required extra articulation work of coordinating tasks and executing them (e.g. coordinating Andy's newsletter efforts and adding content to Spring Creek's Web site).
- Community organizations rely heavily on social capital to fulfill their goals, in the context of both strong and weak ties, at multiple levels of analysis: individual, group, organizational, and community. In Spring Creek, individuals like Lauren, groups like the Web site committee, organizations like Clearwater Conservancy, and communities like the online users of Mambo were all engaged in developing and enhancing social capital.
- Members of community organizations often do not have ample time and resources (e.g. access to training) to learn and use technology. This was the case with Lauren and Emily, which motivated and committed them toward technology involving less cognitive overhead for the amount of invested work and realization of the organization and community's collective benefit.
- For community organizations, knowledge management is even more challenging because of quick volunteer turnaround and organizational leaders being more absorbed in coping up with fulfilling the organization mission because of their lack of resources. Lauren and Emily formulated the strategy of developing technical documentation to transfer their knowledge, often specialized and tacit, to others.
- For community organizations, long-term sustainable use of technology and consequences of its use matters. Spring Creek realized this through their experience with the previous Web site and incorporated the criterion of technology sustainability in their decisions during adoption and evaluation of Web site technologies.

6. Discussion: Implications for designing Web site technology

Although community computing goes back to the 1970s (e.g. Berkeley Community Memory (Farrington and Pine 1997), Cleveland Free Net (Beamish 1995), Santa Monica Public Electronic Network (Rogers *et al.* 1994)), only recently has there been greater engagement between community computing and human computer interaction (see Carroll 2001 for discussion). Community settings present new challenges for designing community-based technology, partly because of their civic nature, which is starkly different from traditional workplace and educational settings.

Our case study of Spring Creek adopting, evaluating, and maintaining Web site technology suggests broader strategies for designing socio-technical interventions. At the most general level, the approach we are pursuing has three design heuristics abstracted from our data analysis. First, we are trying to align and afford new possibilities for participation. This is because community organizations value participation, which is often diverse and requires additional articulation work. Second, we are trying to dynamically manage organizational knowledge and learning. This is because community organizations lack resources and face a great deal of volunteer turnover. Third, we are trying to enhance social capital within community organizations and with the broader community. This is because community organizations are embedded within a system of local relationships (intra- and inter-organization), and the ongoing history of their geographic and larger community.

6.1 Alignment and affordances of new possibilities for participation

Part of the value system for community organizations is their consideration for volunteerism. For example, the John Hopkins Nonprofit Sector project reported that the number of people volunteering in civil society organizations in the 35 countries they studied exceeds 190 million, which represents over 30 percent of the adult population in these countries (Salamon *et al.* 2003). Valuing participation by community organizations is relevant to adoption and design of technology because it is likely that volunteers will participate in and manage technology-related activities.

Because technology is typically not part of the core mission for community organizations, the use of a community-based workforce creates tensions as the organizations work to harness a diverse set of skills. Volunteers and staff members possess a diverse set of technology skills, which makes it difficult to prescribe a skill set while still being participative (McPhail *et al.* 1998). In addition, managing such diverse constituents requires additional articulation work as evident from our case study. This is because it involves increased coordination of the cooperative work processes and operationalization of subtasks (Gross 1999; Gerson and Star 1986).

Thus, one of the concerns for designers of Web site technology is being able to quickly bring an individual on tasks within the bounds of the organizational values and its social structure. This is because community organizations often have ephemeral participation from volunteers, staff members, and so forth, and have limited time within which organizational tasks need to be accomplished. Community organizations also need to reconcile the diverse skills and backgrounds that individuals bring with them, while simultaneously focusing on their organizational mission.

Having fail-safe mechanisms embedded in the technology to support privileges for users can address these concerns. One way to achieve this is to separate the organization's external, public view (actual Web site) from the internal, private workspace (test bed for Web site), allowing users to try, learn, and assess the consequences of their work without affecting the organizational image. In our case study, Spring Creek used the three templates on BRIDGE to develop their Web site content and layout. The Web site templates on BRIDGE allowed Lauren and Emily to moderate and assess the consequences before the changes were actually propagated to the public Web site. Allowing versioning capabilities to modifications could also help in analyzing gradual changes over time. This would support the typical 'undo-redo' features of modifying artefacts.

Supporting privileges seems critical in developing Web site technology for community organizations. For Spring Creek, Lauren wanted a volunteer to update the Web site after it had reached a manageable point, but simultaneously expressed that trust may be an issue with newcomers. Having granularity in the type of privileges could provide flexibility to leaders of community organizations in delegating their work to volunteers. For example, in addition to role-like privileges to access specific Web site content, they can be allocated according to different groups (e.g. 'Newsletter group' for volunteers doing newsletter-like tasks). This could facilitate greater collaboration between volunteers working on similar tasks. Moreover, allowing privileges to change over time can enable technology managers to allocate additional responsibilities as trust gradually builds up.

6.2 Dynamic management of organizational knowledge and learning

By sharing and co-constructing knowledge, individuals contribute to the shared intellectual capital of the community organization (Nahapiet and Ghoshal 1998). Communality (van den Hooff *et al.* 2003)—the collective storing and sharing of information to which all members of the collective have access—is a consequence of knowledge management.

Based on our data analysis of Spring Creek's case description, we noticed that transfer of acquired and learned technical skills is not only more important because of quick volunteer turnaround but also more challenging because of lack of resources to develop such knowledge management practices. One of the practices Lauren adopted in Spring Creek was to document, in one physical folder, all material (electronic and otherwise) related to their Web site. From our perspective, this was an indication of an attempt to build a knowledge-sharing community (Brazleton and Gorry 2003) for Spring Creek. Lauren's main concern was that if she leaves, the tacit knowledge related to the organization's Web site should be preserved and accessible.

In addition to having a shared information repository, an important part of communality is being able to dynamically access the desired knowledge. This was evident by both Lauren and Emily's efforts to actively engaging the Civic Nexus researchers and other knowledge bearers (e.g. Andy) through email. Such email exchanges related to both lower-level technical details, such as understanding the structure of the Web site directory, and higher-level organizational practices, such as how to choose between two Web site technologies. Emily also used discussion forums to share, co-construct, and dynamically access technical knowledge related to Mambo. Her forum correspondences were not only saved online, but Emily also printed each of these threads to add to Lauren's physical folder repository.

To support dynamic management of knowledge and learning, one solution could be a repository of electronic artefacts for a community organization. Electronic artefacts could include Web site versions, emails, discussion threads, and similar products like the ones we observed Spring Creek collect and analyze. This repository could take the shape of a simple file-sharing directory on a common machine in the organization to an online, internal knowledge database that is specialized to the organization's characteristics and its proximate users.

Dynamic management of organizational knowledge and learning is not just related to accessing artefacts in a repository but also people who co-constructed these artefacts and their activities. In community organizations, transitioning between volatile members of a volunteer workforce and quickly bringing their skills to bear on organizational tasks is a challenge. One way to dynamically manage and coordinate volunteering activities over time is to maintain an up-to-date repository of volunteer profiles, including their technical skill set, tasks they worked on, documentation of their activities, and so on. This can allow leaders of community organizations to assess how the skills of new volunteers will align with tasks within their organization. In this way, volunteers can be identified based on their niche skill set. This emphasizes the social component of knowledge management, involving identification of people with appropriate skills and bringing these people together to increase learning, organizational knowledge, and communication (see broader discussion in Ackerman *et al.* 2003).

6.3 Enhancement of social capital within community organizations and with the broader community

In addition to communality, connectivity—the ability to reach other members of the collective—is also a facet of knowledge sharing (van den Hooff *et al.* 2003). Community organizations must sustain and enhance the original social capital with which they were formed and broaden it into a variety of key areas (King 2004). This is important for the purpose of recruiting and developing board members, raising philanthropic support, developing strategic partnerships with other organizations and the larger community, engaging in advocacy, and creating a shared strategic vision and mission within the organization and its members.

Leaders in non profit-like community organizations have an important role in developing social capital and, further, investing their already-limited time in the right kind of social capital to fulfil their organizational mission (King, 2004). At a general level, this involves engagement with both strong and weak ties (Granovetter 1973). Putnam (1993) talks about the ideas of 'bridging social capital' to describe the relationships with people outside one's organization and 'bonding social capital' to refer to the relationships that are developed within an organization.

In our case study, Lauren's attempt to reconcile the decision between BRIDGE and Mambo with both Andy and the Civic Nexus researchers was an example of valuing participation and maintaining social capital. She wanted to satisfy both stakeholders and did not want to lose their goodwill. Her initiative to involve Andy and the Civic Nexus researchers in deciding between the two Web site technologies was an indication of bridging and enriching social capital. This is corroborated in research, for example, that talks about bridging social capital as especially important in community settings to leverage the power necessary to carry out their agenda (Carroll and Rosson 2003; Kavanaugh *et al.* 2003).

The use of Mambo discussion forums by Emily was an indication of developing social capital with the broader community. This broader community transcended the geographical vicinity of Spring Creek, as it was an online collective. The availability of such an online community was one of the criteria for Spring Creek to choose Mambo over BRIDGE. In a way, this online community was the critical mass that embraced a particular technology. It was this critical mass that led to Spring Creek's successful adoption of the technology.

Research in the field of CSCW and artificial intelligence (AI) has created applications that can be understood as technical support for building social capital (Becks *et al.* 2004). One way for community organizations to enhance social capital is through online social networks. An online social network that extends across organizations and into the larger geographical community can possibly help to locate resourceful people according to their volunteering interests, technical skills, social abilities, etc. With larger groups, such as many organizations or a whole community, it is likely that a recommender system can facilitate faster access to more meaningful resources (see broader discussions in Resnick 2002 and Reichling and Veith 2005). For example, an expert-profiling feature could connect an organization to skilful volunteers who have specific skills like Java programming and/or can provide advice on technical issues.

7. Conclusion

We adopted a broader, socio-technical perspective on how community organizations construe, adopt, design, evaluate, and sustain technology in the context of their learning and work practices. This contrasts, in some ways, with current literature on designing technology to support learning that largely focuses on the individual learner or the traditional role of the classroom teacher (e.g. Palloff and Pratt 2001; Pena-Shaff *et al.* 2001; Swan 2001; Tu and McIsaa, 2002: from Klamma *et al.* 2003a). We used the framework of long-term participatory design to understand and analyze community-based learning, based on the notions of developmental and mutual informal learning and sustainability. We used an in-depth case study of a community organization and illustrated design heuristics and features for developing Web site technology to support community learning, community work, and community building. Thus, this paper offers a new perspective on the technological support for place-based, geographical learning communities. Although we presented one case study, the discussion around design implications abstracted from our case study was intended to and can promote constructive debate among the community of designers.

The broader contributions of this paper are twofold. First, we enhance the breadth of empirical studies in context of computer support for learning communities. Few studies have attempted to systematically link community computing to technology design for supporting learning and work practices. Most empirical investigations focus on applications of collective learning environments of students, teachers, and/or professionals, ranging from traditional educational institutions to technology-based experimental facilities (e.g. Yokawa 2003; Strobel 2003; Klamma and Spaniol 2003; Klamma *et al.* 2003b). Our case study of a proximate, geographical community organization, which characterizes many nonprofits in USA (and other places around the world, e.g. non governmental organizations in Europe), adds diversity to such empirical collections.

Second, we contribute to the understanding of technical aspects in community-based learning. The nuances of the community computing context—such as scarce full-time staff members, high volunteer turnaround, and significant reliance on social capital—makes the design space distinct from more well-studied settings such as education or workplaces. The design implications and discussion, based on the analysis of our case study, represent first-order approximations to systematically understand the dimensions of designing for community-based learning and work in community computing.

We believe our paper is of interest to scholars interested in the implications of information technology for community-based interactions and belonging to the broader domains of HCI, CSCL, CSCW, learning sciences, and social informatics. Scholars in community computing can consider the role of long-term participatory design in their own research investigations to engage organizations in meaningful activities and reflect on how our analysis and broader design implications can be useful with respect to their own context. We also believe that our paper is valuable to the general audience of community practitioners and researchers interested in building community capacity using information technology.

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Fostering an informal learning community of computer technologies at school

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Abstract

Computer technologies develop at a challenging fast pace. Formal education should not only teach students basic computer skills to meet the current computer needs, but also foster student development of informal learning ability for the lifelong learning process. On the other hand, students growing up in the digital world are often more skilled with computer technologies than their teachers. We describe an online course design project in which a group of students designed an online health course for their middle school and teachers played the roles of facilitator and learner. We suggest fostering an informal learning community of computer technologies at school as a supplemental method of formal computer education to address the shift in educational context and as a place offering opportunities for students to work on real life projects and solve real life problems.

Keywords: *informal learning community, school context, Web site design*

AMS Subject Classification: 94A99

1 Introduction

Technological concepts and skills are essential in today's world. Computer education is increasingly important at school. In order to keep up with the fast development of the digital world, one needs to master the skill of learning new technologies. Formal education should not only teach students basic computer skills to meet the current needs, but also help students to develop informal learning abilities for their lifelong learning process.

On the other hand, computer education has been a challenge for schoolteachers. Traditional classroom-based learning generally adopts the 'adult-run' learning model in which teachers possess more knowledge about the subject and transmit knowledge to students (Rogoff *et al.*, 1996). However, it is well known that students who grow up in the digital world are often more technologically savvy than their teachers. In some subjects or areas, teachers may not be able to function in their traditionally accepted role as content experts. Moreover, many schools focus on providing the physical infrastructure such as computer labs and Internet access, and have overlooked the need to provide the appropriate program to help the schoolteachers to effectively incorporate information technology into their teaching. For example, in a national survey of teachers, Market Data Retrieval (MDR) reported that 60% claimed five hours or less of training annually (Market Data Retrieval, 1999).

One approach to alleviate the situation is to cede more control to students. In such a learning environment, students interpret and demonstrate their understandings and receive assistance from those who are more advanced in the subject (Hertz-Lazarowitz *et al.*, 1992; Brown *et al.*, 1996). Through the process of articulating, illustrating, and debating, students learn from expressing and negotiating differing views about how to solve a problem or resolve an issue (Chan *et al.*, 1997). Developed from Sweden in the late 19th century, the Study Circle is the idea of people studying in a small group, where the group leader is an organizer who does not possess theoretical qualifications, and group/circle members have no previous theoretical qualifications but practical experience (Brattset, 1982). In the Study Circle, terms applied are *circle members or participants*, instead of *pupils* and *students*, *circle leaders* instead of *teachers* (Bjerkaker, 2003). The Study Circle is a proof of concept that students learn from each other and gain knowledge without teacher supervision.

Another supportive but complementing solution is to better exploit the community resources. The local community presents real life context that students are familiar with and that students can apply computer skills to. Constructivists believe that students learn best when they engage in real activities (Dewey, 1916). Engaging in real life activities helps students realize that their learning is meaningful and learn how to apply their knowledge about the real world to the activities. School is a learning-centred institution that aims to help students learn how to make lives (NOT how to make a living) (Postman, 1995). School is a great and important place to connect community resources with students' education needs with local community. Moreover, often students are interested in learning technologies because learning and using new technologies are fun to them (computer games are good examples). Working on real life problems helps educate them how to apply technologies to better serve society.

Our research group, Civic Nexus, has worked in collaboration with a local high school program that ran head-on into this issue. In working with the program, we observed how a group of students worked with teachers on a technology project in their school. In the process, both the students and teachers acquired knowledge of online technology, but their responsibilities were recast: the teacher played an important role as facilitator in this learning process, however the students were more knowledgeable about the technology than the teachers and became the experts, taking the roles of instructors and consultants (Xiao *et al.*, 2005).

Based on the experience of working with the local high school program, we suggest fostering an informal learning community of computer technologies in schools, as a supplemental method of formal computer education and a means of helping teachers to integrate technology into school curriculum. We begin with the introduction of Civic Nexus research, followed by an in-depth description of the technology project-–– designing an online health course for school. We then discuss a few design implications of creating a Web site for the informal learning community. We conclude with discussion of the evaluation of the community.

2 Civic Nexus: Encourage Informal Learning of Computer Technologies in Community Groups

Civic Nexus is a three-year community-oriented participatory design project. Helping community groups sustain technology learning and development in their organizations is the goal of our research. Built on the previous methodology that blends ethnographic methods with long-term participatory design (Carroll *et al.*, 2000), we (as Civic Nexus researchers) work with community groups to investigate the existing infrastructure of technology support in community groups as well as help them develop their technology capacity through various strategies, such as enriching community activities through technology implementation, developing and maintaining community Web site, and developing strategies to manage technical expertise in their organization (Merkel *et al.*, 2004). We also collaborate with community groups on technology projects to foster informal learning of technologies in the community. In terms of promoting sustainability, we see community groups as owners of technology projects. We believe that supporting informal learning in community groups is crucial to help them meet the technology needs and sustain technology adoption in the organizations.

2.1 Informal Learning in Community Groups

Technology implementation is a challenge for small community groups that have scarce resources (McPhail *et al.*, 1998; Mogensen *et al.*, 1998; Suchman, 1996). There are often few full-time staff members in these groups and they are usually already overwhelmed by their workload. Limited (if not no) financial resource makes it unlikely for community groups to afford formal training courses for members. Non-technical volunteers usually dedicate their long-term effort to the community services and civic engagement, but technology volunteers who help with community technology issues often come-and-go.

The context of small community groups makes it especially important to offer informal learning support in the community groups. Informal learning takes place in a wide range of settings, including both the non-education centred places like clubs and shopping centres, and the education centred environments such as public libraries, and schools (King, 1974). 'Informal learning can be unpremeditated, self-directed, intentional and planned' (McGivney, 1999, p1). Informal learning occurs continuously throughout life, requiring no particular preparation (Candy, 2002).

Informal learning is explicit learning that is not constrained or supported by prescribed frameworks (Eraut et al, 1998). In our fieldwork, we have observed that people do learn technologies informally. For example, we have observed that members of a watershed group formed a learning and design group in order to develop a community Web site; a program administrator of a historical society asked us to draw a diagram for the process of uploading a file to a Web server; and an executive director of a leadership group asked the technician who was fixing the computer crash problem to explain what the technical term FAT (File Allocation Table) means.

We adopt the definition of informal learning by McGivney (McGivney, 1999, p1-2) in Civic Nexus research. By their definition, informal learning is the learning that: a) occurs outside a dedicated learning environment and may not be recognized as learning (e.g. listening, observing, interacting with others); b) involves non-course-based but intentional learning activities, which take place when there are explicit interests and needs from community members. According to this definition, we consider students' learning process throughout the project as informal learning although the project was carried out in the context of school.

3 Work with a School Program – towards an Informal Learning Community

At the beginning of the Civic Nexus research, we held a workshop in which invited potential community organizations to partner with us on the project, including the Learning Enrichment Center/Gifted Support Program (LEC), a program belonging to the State College Area School District (SCASD) (http://www.scasd.org/249710010249155/site/default.asp). LEC was planning on an online course design project and expressed their interest in collaborating with us. We worked with the student group and a LEC teacher on the project from October 2003 for approximately 15 months. After that, we continued to monitor the activities of the group through their mailing list.

3.1 Background of the Online Course Design Project

Different from the other community groups that are civic-goal oriented, LEC is a program that is dedicated to support informal learning of students The program provides learning opportunities to students who are interested in exploring areas beyond the standard curriculum. It supports the development of a range of interests such as art, writing, and mathematics through various activities, e.g., field trips, guest speakers, and training sessions. It also encourages students to develop problem solving and research skills through participation in real world projects.

Our work with LEC is about understanding the process of one of their technology projects – putting a health course online. As online courses becomes increasingly popular, the high school and LEC program decided to push their teaching practice beyond the current classroom-based and correspondence models, towards online education. Currently, the students may take the health course in a traditional classroom setting, or do self-study on the subject based on the course materials handed out by the teacher, and then take a final exam at the end of the semester as what the school refers to as a 'correspondence course'. It has been noticed that there are increasingly more students take the health course via correspondence (over a hundred every year). LEC program believes that it is because the correspondence model offers more flexibility and the course content itself can be easily self-taught, students prefer correspondence to classroom learning for the health course. LEC program decided to select the health course as the first one in their online course design project, assuming that the online model could attract the students because of its even more flexibility than correspondence, and eventually may replace the correspondence model.

A LEC teacher advertised the project and recruited ten teenager students who were interested in learning Web technologies when the project first started in October 2003. The level of each student's computer skills ranges from very basic technical skills like scanning to more advanced like programming in C++ and writing shell scripts for servers. A high school senior joined the group in January 2004 and became the administrator of the course Web site. The LEC teacher was comfortable with basic computer technologies like email or Web surfing but did not have experience about online course development.

We were initially consultants that provided advice about the Web site design, such as commenting on the Web site layout, suggesting course management software, and hosting a lab session at our university. Our role became gradually passive as students were able to be more control of the design process, and we acted as occasional 'hint giver', or as 'active listener' who encouraged reflection on the project. We also took a passive role as meeting observers and email lurkers, in line with our research belief that community groups should offer support for informal learning.

3.2 Methods

3.2.1 Data Generation

We conducted face-to-face open-ended interviews (some of interview questions were asked through emails) and we observed the process through participant observation. We interviewed the SCASD director once and the LEC teacher five times. The interviews covered a broad range of topics related to the project such as the background of the LEC, the goals of this project, and issues related to the design process. At the end of the project, we interviewed the teacher about her learning experience with technology during the project and her feedback on working with this students group.

Since our interest is the process of the project, participant observation was our major data generation technique (Mason, 2002). We participated in the weekly design meetings in which students discussed and worked on the design of the online course and joined the group's mailing list. We also videotaped the presentation the student group gave to the schoolteachers and school administrative about the course Web site they developed.

We also collected secondary data. For example, we collected the design meeting minutes, design artifacts and the final version of the Web site. Finally, we produced a questionnaire to capture students' learning experience during the process.

3.2.2 Data Analysis

We analyzed the data using the general analytic strategy of developing a case description (Yin, 2003). The descriptive approach helped us identify the complex stages of designing a Web site through group effort. In this project, a group of students gathered to design the online course, under the facilitation of a LEC teacher. We view it as a collaborative learning process in our analysis, reflecting important factors that impact on the learning outcome.

3.2.3 Data Evaluation

Rigor is a challenge for qualitative research. Dubé and Paré investigated the level of methodological rigor in positivist IS case research conducted over the past decade (Dubé *et al.*, 2003). In Civic Nexus research, the multiple sources of data collection provide evidence of data triangulation. We (as Civic Nexus researchers) meet biweekly with the rest of the research group to report fieldwork including interviews and observations, and reflect on the collected data for a better understanding of the process. The group process in data analysis assures the inter-coding reliability. As a way of doing member checking, we sent the LEC teacher our interpretation of the project process accounting for our bias in the interpretation.

3.3 Design Process of the Online Health Course

Picture this – teachers are sitting in a computer lab, listening attentively as the students explain, using a PowerPoint presentation, how to use a course management system, and then quiz the teachers on their retention of the material at the end of the lesson.

This is what happened in the project of designing the online health course in which an LEC teacher played an important role as facilitator and the students took the roles of instructors and consultants who are more knowledgeable on technology contents than the teacher. During the project process, the students learned to use the open source courseware Moodle and designed the course Web site. After the course Web site was developed, the students gave a PowerPoint presentation to schoolteachers and school administrative, describing the implementation details and pragmatic benefits of the Web site they built and the design process they followed. At the end of the presentation, students gave the teachers an 'in-class' quiz to examine how much the teachers had learned during the presentation, and answered the teachers' questions and concerns about offering online courses at school.

Later, the students took part in the design of evaluating the developed online health course. Together, the LEC teacher and the students constructed a questionnaire for students who would take the online health course to evaluate the format of the course, giving input on both the teacher's course evaluation expertise and the students' knowledge on evaluating technologies. The questionnaire covers a wide range of issue, such as the helpfulness of online forums and online chapter quizzes on learning health, comparison between the online course and the correspondence course, the benefits and disadvantages of taking online courses, and user interface design issues like ease of Web site navigation, problems with course Web site (e.g., technology difficulties). Throughout the process, students are assigned different tasks to work on by the LEC teacher based on their computer skills and preference. These tasks include scanning materials, uploading files, designing quizzes, and so on. For each task, there were at least two students who work together. The LEC teacher facilitated and monitored the progress. For detailed description of the project process and the role shifting between the students and the teachers, please refer to (Xiao *et al.*, 2005).

4 Towards an Informal Learning Community of Computer Technology

Learning communities usually imply places where people share knowledge, cooperate, and work together on learning activities (Baker *et al.*, 1996; Bauman, 1997; Cross, 1998; Haythornthwaite, 1998; Hill *et al.*, 2000; Kowch *et al.*, 1997; Palloff *et al.*, 1999; Rasmussen *et al.*, 1997; Raymond, 1999; Riel, 1998; Schwier, 1999; Misanchuk *et al.*, 2001). School is a formal learning community where students are brought together to learn subjects and encouraged to share their experience and knowledge, but 'the learning in question will be much more restricted and externally defined than an informal learning community' (Romiszowski *et al.*, 2003, p.408). In an informal learning community, learners are self-selected and gather together for informal learning purposes (Romiszowski *et al.*, 2003, p.408).

After completing the design of the online health course, the students continued to learn computer technologies together. The positive learning atmosphere of the project attracted other students to join them (as of April 2005, there are seventeen students on the mailing list). The students formed an official computer club called TECS under the supervision of the LEC program. In the computer club, the students discussed various project ideas including 'to set up an email server on our TECS server; Computer classes for students and teachers; Even more personalized teaching one on one tutoring; Graphic design, Web page design; Build computers for people; Computer modification/upgrade; LAN party; Game server Rental' (evidenced from the email dated 10/14/2004).

TECS is not the first computer club supervised by LEC. Bell Grant was issued to the program ten years ago to support a computer club for students who are interested in exploring computer technologies, and a NERDS group was formed under the grant (all members of the NERDS graduated before the online course design project). However, TECS is the first one at school that is interested not only in cool technologies, but also in helping school and others in the local community. For example, the list includes ideas like 'Computer classes for students and teachers', 'Build computers for people', and 'game server rental'. TECS computer club is not just a computer club that a group of students get together to learn and play with cool technologies any more.

From our experience of working with the LEC program, we suggest an informal learning community of computer technologies at school as a complementing method of formal computer education and a way of helping teachers integrate technologies into school curriculum. The community has four goals as follows:

4.1 Support students to work on real life projects

Constructivists believe that students learn best when they engage in real activities. Authentic activities motivate students as the process itself demonstrates that their learning is meaningful and they can apply their knowledge about the real world to the activities.

The project of designing an online health course is an authentic learning activity. The problem itself is a real life problem. The students were very familiar with the context of the project, because it was not just any Web site design project, but one of designing an online course of their own school! In fact, among the students group who designed the online course, some of the students had already taken the health course through correspondence and some had the experience of taking an online course. These motivated students to be very active since the beginning of the project. For example, in brainstorming sessions, students suggested many functions that an online course should have based on their experiences, such as 'Site should include a general picture of how the class is doing, both on-line & traditional; Site should include a timeline and a suggested deadline; Site could include auto quizzes with optional retakes; Questions for quizzes would come from a bank of a predetermined number and would be chosen randomly; Hints could be an option; Client would receive immediate feedback on quizzes; The site should have several times to chat with the teacher'. The functions suggested by the students demonstrate how they understood an online course should be (The LEC teacher was mainly a facilitator of the meeting and note taker of the ideas.

By engaging in this real project, students learned Moodle quickly. The LEC teacher introduced Moodle to the students on 12/2/2003 by email. We provided the lab session about installing the software on December 18, 2003. After that, there was a winter break after that until early January 2004. Since then, the students went on to learn the courseware and finished putting one section of the course online by February 2004, and gave schoolteachers and administrative a tutorial-like presentation on how to use Moodle for developing an online course on March 15th 2004. They carried out all the project activities after school hours. We think it was a successful example of learning a new technology within the short amount of time, especially as the students learned Moodle all by themselves starting from various levels of computer skills. The success of this design project at school in an informal learning environment demonstrates that support authentic learning in an informal learning community is feasible and is a great approach to engage students in informal learning activities.

The goal in the authentic learning model is not just about helping students learn the content knowledge of the subject, but also helping them interpret, process, and apply them. The example of brainstorming ideas shows that students assembled their prior knowledge about the course itself and the online course format to the design project. The email dated 11/26/03 shows that the students not only discussed Web site design issues, but also complex real life issues related to offering the course at school (see below):

> 'Determine who can take cyber class and establish guidelines for:
>
> number of students
>
> limited number ???
>
> when it will be offered
>
> class will be offered Fall, Spring, Summer

time frame

class will have definite starting and ending dates

progression

on-line class will have a linear progression

Teacher Concerns shared by Mr. XX [he is the health course teacher and he was in the meeting]:

who will monitor the class

how will the traditional class be replicated on-line

would it be possible to include a project

can current power point presentations be included

We agreed that Mr. XX should join us when we begin working on the actual construction of the site.'

Here is another email from a student in the group showing the serious thought he gave to this real life project.

> 'One of the best things about having a computerised class is getting the computer to do some of the teacher's work. I therefore think that after we get all this in, we should set a goal of going back and changing as much as we can into Moodle activities and quizzes. The vocab sections especially are just begging to be graded electronically. Lets try to have a meeting soon when everything is up there, and we can discuss that.'

The designed health course not only demonstrates their learning outcome of the technology, but also reflects the students' understanding of how an online course should be designed. Moreover, the students' presentation illustrated how the students articulated their work, and interpreted their understanding of the project. The LEC teacher acknowledged that the students learned a lot in terms of communication and collaboration skills besides technology, '*[they] need to communicate to staff and public [to make the project succeed]*'. Most of students said that the hardest part of the project was to organize course materials and design the Web site. For example, one student said that '[the hardest part of the problem in the project was] figuring out the best way to put things into the course [Web site]'.

Students also gained the experience of coordinating with people that are involved in this real life project. For example, when the students group was looking for permanent host for the online course, a student talked to the technology director of the school to ask for help, as shown from the email dated on 12/15/2004

> 'XX had a meeting with XXX who will be setting up the TECS server in the North Building with XX as admin for our cyber site. This will hopefully happen in January.'

Evidenced from the email, the high school freshman XX not only worked as designer in the project, but also as a project representative negotiating with school administrative.

4.2 Encourage peer help with technology learning

It is well known that people learn together and share knowledge in community. For example, Rosson and Carroll discussed the informal and collaborative learning between kids and senior community members when working together on computer simulation project (Rosson *et al.*, 2003). However, there is something new to the informal learning community in the context of school and is worth being emphasized here. It is typical at school that groups to help advanced students learn more and groups to help students who need learning aids differ substantially. This informal learning community offers a place that invites students at all levels to join the learning activities. The informal learning community provides a less competitive study environment than a classroom and helps engage students at different levels in collaborative activities. Collaborating with peers at different levels of computer knowledge helps students realize the importance of cooperation, and stimulates students who are more adept at computer skills to help those who are less competent. At the beginning of this project, because all of the NERDS group members had graduated and LEC program did not have a computer group, the LEC teacher decided to recruit students who were interested in learning technologies. It is this recruitment that was based on the interest not the level of computer skills that enabled grouping students who are good at computers and who are not together, and it worked out great! The LEC teacher commented, 'The students truly amaze me. They are very committed, knowledgeable and very willing to help each other to troubleshoot problems or teach a new concept'. For example, after he learned how to create a unit of quizzes for the online course, a student wrote instruction about it for his peer students who need to work on this task. In order to ensure that his team members would understand the procedure, the student wrote down eleven detailed steps (one with seven different subparts) and added at the end of the instruction that:

> Note: You can also add questions by typing a special .txt file. The details of this format can be found by clicking on the yellow question mark by the 'Import Questions from File' button in the category-editing column

In an informal conversation with the LEC teacher, she told us that previous NERDS group members were very good at computers but they were interested only in learning advanced technologies. Moreover, 'if you don't speak the same language (about technologies), you don't get much interaction'. Through working with others at different computer levels, the TECS club considered the learning needs of less advanced students. For example, one of the TECS ideas is 'Even more personalized teaching (and) one on one tutoring'.

Besides supporting collaboration of students at different levels of computer skills, supporting intent participation is also important in this informal learning community. 'Intent participation is a powerful form of fostering learning' (Rogoff *et al.*, 2003, pp.176). In intent participation, people learn through participating in ongoing or anticipated activities, with attentive and intentional watching and listening. 'Learning through observation and listening-in is pervasive in children's lives and is effective' (Rogoff *et al.*, 2003, pp.176).

Listening-in includes both eavesdropping and overhearing (Rogoff *et al.*, 2003). In the course design project, most of meetings were hold in the computer room at LEC. Sometimes there were other students in the room checking emails, browsing the Internet, or working on their homework during the meeting. In the middle of the project, the LEC teacher introduced a female student who was interested in the project to the group. This student had a friend in the design team, and prior to join the project she was sometimes in the computer lab when the student group met. Although we did not have data to explain why she became interested in the project, we believe that her awareness of the project process and what the project members were doing played an important role.

Students in the group also learn from their group members through intent participation. For example, one student emailed the group for help on a technology issue claiming that he is willing to learn through intent participation (from an email dated 4/19/2005):

> 'One more thing... I am unable to upload files to the "siteFiles" section, only the "English 12" section. This isn't much of a problem, except that there is one image that needs to go in a folder in the "siteFiles" part. Could someone please move the file "Wolves0001.5.jpg" from the 4th quarter folder of the English 12 section to the "\4th Quarter\Of Wolves and Men\" folder of the "siteFiles" section? Either that or **show me how to do it myself**.'

'Learning through keen observation and listening, in anticipation of participation, seems to be especially valued and emphasized in communities where children have access to learning from informal community involvement' (Rogoff *et al.*, 2003, p.176). In this informal learning community, students are not only invited to work with others on meaningful activities, but also encouraged to 'observe' the activities.

4.3 Encourage teachers to work with students as teams

McGivney and her colleague's study demonstrated that a key factor in widening participation and encouraging educational progression is people who inform, advise, encourage informal learners, and motivate and help them to engage in new activities including formal and certificated programs (McGivney, 1999, pp.25). Teachers are the 'key' people in this informal learning community. Students look to teachers who possess advanced knowledge of computer technologies for technology guidance, an understanding of the complex phenomena of the real world and the social impacts of the technologies, and for knowledge of how to apply technologies to solve real life problems and enhance real life quality.

Schoolteachers benefit from working with students. The online course design project illustrated that teachers can facilitate computer technology projects even if they do not know how to implement the technology (Xiao *et al.*, 2005). Working together helps teachers learn information technologies from the students who are more knowledgeable on computer application and learn together with students through meaningful activities.

Authentic activities related to school education not only motivates students to quickly participate in the process because they are familiar with the context of the real world, but also helps teachers integrate technologies into curriculum. This also increases awareness of the informal learning community to other teachers who are not involved in the projects and encourage them to join in the community. For example, in the online course design project, although English teachers were not engaged in the design, they were interested in what the student group was doing, and attended the presentation by students. After the presentation, English teachers decided to put an English course online and asked TECS students for help.

Different from using authentic learning as a formal education method, teachers' role in the informal learning community is not a true evaluator of students' behaviour any more. They are community learners who are more experienced in real life experience. Students' role is redefined as well in the interaction with teachers. They are not only learners, but also consultants helping teachers on technology if needed, and shapers of the community who propose ideas for community activities, carry out technology projects, and recruit new members.

4.4 Create and Maintain Connections with the School and the Local Community

The online course design project at LEC is different from a design project for a technology course. A project assigned through a computer course typically involves only the students and the course instructor, and the students usually need to coordinate with the course instructor and/or their project team members only. This design project is different. It happened in the context of the school, not a course. It has involved coordination with other school members such as the health course teacher who provided course materials, the other LEC staff members who helped on hardware support, and other teachers, like English teachers, who attended the presentation and joined the discussion of the course Web site design.

The LEC teacher told us that she became to know that Moodle is a courseware for developing online courses and students could use it to design the online health course in an informal conversation with the technology director and a technology service person of the school. In Sept. 2004, the server of the online course went down. The LEC teacher had to call the service help for Go Daddy, where the domain of the online course was registered (a commercial organization that offers Web hosting service).

Finding a permanent host was a big issue. Not able to receive permission to host the course on the school server, the LEC teacher called Adelphia to check the cost and process for getting a static IP from the company in early October 2004 as shown from the email dated 10/11/04:

> ' Sever status - Server is now up and running. Thank you, XXX. We are looking into getting a static IP to keep our server up and running. XXX has called Adelphia and they do provide static IP for this area. She called XXX from computer services and we should hear within a week as to the cost and process.'

Not until December 2004 did the school decide to host the course Web as shown from the email dated 12/15/2004

> 'XX had a meeting with XXX who will be setting up the TECS server in the North Building with XX as admin for our cyber site. This will hopefully happen in January.'

A personal email from the LEC teacher to one of the researchers on 12/19/04 hints the difficulty in getting support from the school when trying to get a permanent host:

> 'XXX has approved the static IP and XX will be network admin. It has taken us this long!!!!! but we kept on trying.'

In both emails, XXX is the technology director of the school. All these examples illustrated that a real life project can involve social networking of the real world, and the difficulty of coordinating with other people who are not directly engaged in the project.

Social capital is about how people build and maintain active connections in a social entity (e.g., an organization, a community, or a civil society) (Coleman, 1998). Rose defines social capital as repository of individual's formal or informal social networks for producing or allocating services (Rose, 1999). A social network is a set of individuals or groups who are connected to one another through socially meaningful relationships (Wellman *et al.*, 1988). In order to carry out the project smoothly and successfully, the informal learning community needs to expand its social network through creating and maintaining connections with its broader social context, the school and the local community.

5 Design a Web Site for the Informal Learning Community

In a typical virtual learning community, members are usually located at different places and seldom meet with each other in real life. Most of learning activities in the community are carried out through virtual collaboration using Internet. The informal learning community we discussed in the previous section is different. Its members are from the same school and face-to-face interaction is the major means for carrying out learning activities among the members.

However, Internet still plays an important role in such an informal learning community. In the design project, although students met once a week to discuss project related issues and work together, the group still used a mailing list to send out meeting minutes, update information about the project issues, and ask for technical help, as shown in the email examples we provided in the previous section (e.g., email dated 11/26/03, 10/11/2004, and 4/19/2005). Students also used the online discussion forum provided by Moodle to help each other on learning Moodle technology. For example, a student posted a question on the Web site about where to put scanned worksheets on 05/14/2004, and a reply message was posted on 05/15/2004 morning with detailed instruction of uploading files to the Web site.

The examples of the design project illustrate that students in today's world are used to communicating electronically, and online communication helps collaboration on projects even though students meet face-to-face regularly. Online interaction is expected in an informal learning community in today's digitizing world. A Web site for the informal learning community that considers each goal of the community helps improve learning outcome of the learners, coordinate community activities, and increase the visibility of the community in a broader context. Bruckman classified four categories of educational use of the Internet: information delivery, information retrieval, information sharing, and technological samba schools (Bruckman, 1999). The four categories are in the order of decreasing emphasis on information and increasing emphasis on community and the social context of learning. Based on this categorization, we view a Web site of the informal learning community as a place for students to deliver information, retrieve information, and share information, and one kind of technological samba schools that emphasize the role of authenticity in learning to relate the learning situation to the real world. The Web site of the informal learning community focuses on development of learners' informal learning ability and encourages learners at different levels of computer skills to participate.

In this section, we discuss a few design implications of the informal learning community's Web site, taking into consideration that members share the same school history and meet physically on a regular basis. As this is a community not only for advanced students, but also for students who are in need of help on learning basic technology. The Web site should be, therefore, attractive to students of all levels, instead of using too many technology jargons on the Web site. For example, the Web site of k-8 interesting projects uses some pictures of the projects and an image of a funny painting boy on the Web site to attract the kids to read the Web site, and the simple look makes it relatively easy to navigate to other Web pages (http://www.alleghany.k12.nc.us/ses/page3.htm). Another good example is the Web site created by Howard Hughes Medical Institute that invites kids who are interested in exploring biology (http://www.hhmi.org/coolscience/). The Web site uses colorful and funny image icons to substitute text or buttons as hyperlinks to other Web pages. The Web site of Education 4 Kids presents a much more professional look and may be actually less attractive to kids to engage because of its formal style (www.edu4kids.com). The Web site of MySQL discussion forum presents a lot of technology jargons and very 'cold' look interface, not attractive at all to young kids who have little knowledge about MySQL (http://forums.mysql.com/), and is the last kind of interface we would suggest for designing a Web site for this informal learning community.

Provide Online Meeting Notes with their Own Communication Spaces

The fact that major activities of a real life project are through face-to-face interactions in the informal learning community implies that the design of the community's Web site needs to focus on how to integrate students' collaborations in physical place into the virtual space. One technique is *to provide meeting notes on the Web site each with a* *communication space*. Typically, online meeting notes function as an archive of the project only. By making the note of each meeting the topic of a threaded discussion, students can react to the meeting notes online, such as updating the status of the project after last meeting, questioning some issues discussed the meeting, proposing new understandings of the problem covered in the meeting, etc. This feature combines the communication happened in physical places with the communication happened online, assumed that it will help integrate activities happened in physical places into virtual space. This feature can also be considered as an *interaction-oriented structuring tool* (Weinberger *et al.*, 2003) that supports the students to reflect on the meeting content such as their decision of the project, their proposed solutions of the problem, and their understanding of the problem context.

Support Different Views of a Project in the Community

Working on real problems, students interpret the process based on their own understandings of the complex social phenomenon. Students may therefore hold different views of the problem and have different understandings of solving the problems. This sets another design focus of the Web site, that is, to *support different views of the project*. In physical setting, students discuss their own understandings of the problem during the meeting and the activity. Stahl *et al.* argued that students should be able to construct personal views with an existing CSCL knowledge space to facilitate divergent thinking (Stahl *et al.*, 1999). Providing an online discussion forum for each project helps students elaborate their opinions and ideas verbally in the virtual world.

Provide Project Template to Help Students Organize Real Life Projects

In a technology project of a computer course, usually the problem context is already set in the project description that is written by the course instructor, and the instructor often suggests facets or issues to pay attention to for the project. The focus of the project is often on the implementation of the technologies only ignoring socio-cultural factors that might affect the project outcome if it were a real life project. In the informal learning community, the students need to be more self-dependent when carrying out authentic activities, and find out what are the factors that may affect the project outcome. Considering this context, the Web site can provide a *project template* as a means to help students outline the project, organize their project brainstorming systematically when they look for other influencing factors to consider in the project besides technology issue. Below is a sample *project template:*

Project Template #1

Project Title:
Project Idea:
Team members:
Software needed:
Network issue:
Need coordination from:
Who will benefit from the outcome, and how?

Drawbacks/Trade-off:
Who to Contact:

Weinberger et al defined *content-oriented structuring tools* as the tools that provide structures referring to the content to be learned (Weinberger *et al.*, 2003). The content-oriented structuring tools foster knowledge communication in collaborative learning environments and the outcome of collaborative knowledge construction (Fischer *et al.*, 2002). The authors presented one example of content-oriented structuring tools, the prompt cards with meaningful questions about the content. The *project template* can be viewed as a template of content-structuring tools that helps students focus on the major issues that need to be considered in a real life project. For example, the issue of *trade-off* in the *project* template motivates students to think and discuss the pros and cons of the project, of the technology to use, and of the solutions of the problem, etc. Describing the project with templates also help students to get familiar with the real life work style that usually requires a certain format of documentation such as reports for the work.

Provide a Tailored Public Community Discussion Forum with a Level of Anonymity

Collaboration with others is powerful in learning process. People learn by interacting with others interpreting different perspectives, working with others co-constructing new knowledge. One example that looks at using technology to encourage community members to help each other is the project of Pearls of Wisdom (POW) that provides digital tools for development of a network-wide community that values the contributions of technical expertise from individuals and facilitates the asynchronous sharing of this communal knowledge (Chapman, 2002).

In designing the Web site of the informal learning community, supporting intent participation of the community activities encourages students to help each other. Supporting intent participation means to support for observation, including watching, active listening (eavesdropping), and passive listening (overhearing). Suggestions from learners who are more experienced and discussions that are embedded in the ongoing activity often enlighten learners' keen observations (Rogoff *et al.*'s study, 2003). Making the discussion forum of the project available to all students provides a chance for students to 'listen to' what the students have discussed. Making the meeting announcement and meeting minutes available provide awareness of the project process and implicitly invites all students who are interested to join in the activities.

Online discussion forum is an effective tool to support both asynchronous and synchronous discussions. Providing a community discussion forum supports members to communicate with each other about technology issues through the Web site. In supporting learning from collaborative design, Lid and Suthers implemented artifact-centered discourse and threads that live in multiple discussion contexts, and obtained excellent results in terms of quality and quantity of discussion in their empirical study (Lid *et al.*, 2003). To support flexible collaborative distance learning, Haake et al proposed a CURE learning platform that support the implementation of a variety of tailorable learning environments (Haake et al, 2004). In this informal learning community, a tailoring technique for the community discussion forum is necessary for students to exchange learning experience at different levels of computer skills. To enable students to discuss technology issues at different levels, the Web site can classify the community discussion forum into different sections, such as *advanced tech talk, help you help me,* and *what's new about tech.* On the community Web site, providing a keyword based search engine that can search across the different discussion forums helps members to look for common information from different discussion context.

It challenges the traditional roles of teacher and student when teachers ask for technical help from technology-savvy students. One method of helping engage teachers in the learning community is to allow members a level of anonymity in the discussion forum of the Web site. By doing so, it is less uncomfortable for teachers to join in the online discussions.

Provide a Project Advertisement Space for Teachers

Another approach to encourage the participation of teachers through the Web site is to provide a place for teachers to propose teaching related projects. For example, a physics teacher may want to demonstrate the concept of gravity using Flash, but needs help on learning Flash. She/he can propose the project idea on the Web site and calls for students who are interested in assisting in the task. School projects, especially those that are related to teaching practices, make it easier for teachers to participate in the activities. This collaboration helps not only teachers learn technology and integrate technology into the curriculum, but also helps students understand the idea behind the project as well, e.g., understand better the concept of gravity when working on the Flash project with the physics teacher. Providing a separate place on the Web site for schoolteachers to propose project ideas explicitly encourage teachers to work with students.

Provide a Online Information Repository for Maintaining Local Connections

Social capital articulates the networks of trust and reciprocity in which actors are interconnected with each other (Borgatti *et al.*, 1998). The more interconnected the actors are to each other, the more they trust and share resources with each other, and thus the group/organization as a whole benefits. Acknowledging those who have coordinated community's projects on the Web site provides positive atmosphere for creating new connections and maintaining the existing connections.

Providing a repository of connections in the Web site helps members to store and retrieve connection information. When the LEC teacher contacted Go Daddy for helping on the server, she sent an email to the student group as follows:

> 'The server has been down… On Friday XXX called the service help for Go Daddy. She spoke to XX (e-mail - *******) XX said we need to log in and request *****. The 800 number is ******* for additional help. X hopefully will be able to help us with this. In any event, XX, said to call or e-mail and he would assist us. He said it was not a problem and we should be up and running as soon as we take care of this issue.'

The email implies that a connection was created between XX, the technical consultant at Go Daddy, and the online course design project. The email address of the technical consultant at Go Daddy and the 800 number are great information to maintain this connection and should be archived.

In one computer lab session, one student had problems with MySQL database in a computer lab session. Knowing nothing about MySQL database, the teacher looked for technical help using her social network. She first looked for a senior student who she knew could probably solve the problem, and when that student could not be reached, she called her son who is a Website developer in the Pennsylvania State University to help the student. In this case, a connection is made between the LEC teacher's son and the project, based on the teacher's social network. Archiving this as a possible *ask for technical assistance* connection may help on other projects some day, even if the LEC teacher is not the facilitator any more.

The community also needs to increase its visibility in the school in order to create connections. One way to do so is to provide a link to the community Web site on the school Web site.

Table 1 summarizes the techniques we discussed and how they are linked to the four goals of the informal learning community.

[Insert table 1 about here]

6 Evaluation of the Informal Learning Community

Acting as a complementing method of the formal education at school, the informal learning community offers opportunities for students to work on real life projects and solve real life problems. At the end of the Web site design project, the LEC teacher commented on the students' learning progression, 'The students have learned very much in this area [technology]' '[they learned how to] back up the database, format new material online'. She also acknowledged that the students learned a lot in terms of communication and collaboration skills, and have learned that '[they] need to communicate to staff and public [to make the project succeed]'. Students also acknowledged their learning progress in answering the open-ended questionnaire. For example, one student acknowledged that he had learned HTML during the process. Another student said that he had applied what he had learned in this project–how to design interface layout in the project, to many of his poster projects.

Computer skill that students gain in participating the activities of the community is only part of the learning outcome. After the course Web site was developed, the students presented their work to schoolteachers and school administrative. They organized the presentation by themselves: they decided the topics to be covered in the presentation, format and flow of the presentation, and they even designed a quiz to test how much the teachers have learnt in the presentation. The presentation was an evaluation event of the students' work and it was a big success: teachers were very impressed by students' work and how much students have accomplished in this informal learning activity. Although the Web site project started with designing an online health course Web site, the presentation that students gave impressed English teachers and they contacted the student group for help on designing online English course Web site. As of Fall 2005, the school is piloting the English 12 class. The students are helping designing an online History class. The LEC teacher commented, 'the students (who are taking the English course) so appreciate it and the professor (i.e., the English teacher) is equally pleased that his students are using it to succeed in his class'.

Because of the scale and range of activities that informal learning involves, it is difficult to quantify the progression of informal learning process, and the impact of informal learning on an individual can be long-term effect. In general, learning progressions from informal learning activities can be classified into four categories (Foster, 1997): a) personal progression where participants gain greater confidence and self-esteem, thus increasing self-efficacy (Bandura, 1997), achieve better understanding of subjects, change career plan, and improve literacy; b) social progression where participants create wider social network and increase community participation; c) economic progression where participants get better jobs and better pay; and d) educational progression where participants continue learning in a more systematic and intentional way. Evidence demonstrated that community-based learning had led to significant self-development outcomes such as greater autonomy, improved personal and social skills, and significantly increased self-confidence and self-esteem (McGivney, 1999, p79). In this online course design project, a senior student who is one of the Web site administrators decided to go to School of Information Sciences and Technology at the Pennsylvania State University after graduation. After the Web site design project, the students group formed an official computer club to continue working together exploring other community projects such as helping schoolteachers install computer software and hardware, learning to design game tools, and helping other students on computer learning. Evaluation of such an informal learning community is a long-term process. As a primary evaluator, school has the responsibility of fostering the community and guiding it to contribute to the pedagogical outcome and to students' success in real life in the future.

7 Conclusion

Computer technologies develop at a fascinatingly fast pace. One needs to keep learning new technologies in order to keep up with the fast development of the digital world. Formal education should not only teach students basic computer skills to meet the current needs, but also foster student development of informal learning ability for the lifelong learning process. On the other hand, schoolteachers face the challenge of integrating technology into curriculum. Based on the experience of an online course design project, we suggest fostering an informal learning community of computer technologies at school to address the shift in educational context.

In 1916, John Dewey was quoted, 'From the standpoint of the child, the great waste in school comes from his inability to utilize the experience he gets outside…while on the other hand, he is unable to apply in daily life what he is learning in school. That is the isolation of the school—its isolation from life'. The proposed informal learning community helps bridge the school and non-school life by encouraging students to engage in authentic activities. It has four goals: a) support students to collaborate on real life projects; b) encourage peer help with technology learning; c) encourage teachers to work with students as teams; and d) create and maintain connections with the school and the local community. We have discussed a few implications of designing a community Web site to support such an informal learning community, whose members meet both online and face-to-face sharing the same school context.

Postman and Weingartner (1973) discussed what a good school should be. A good school should have the time structuring that allows children to learn things at various rate and support activities that have some empirical and rational basis and are relevant to children's lives. A good school's activities should involve large percentage of students' work, establish and maintain the connection between students' activities and scholars' work. A good school uses the resources of the whole community so students get to reach real people and problems outside the school walls and encourages students with different background and ability to participate together. A good school encourages its teachers forgo conventional authoritarian role so as to provide a more collaborative supervision atmosphere and students also have opportunities to supervise themselves. A good school invites people with various background including interested laymen, professionals, and even students to join teaching activities and encourages its students to participate school administrative activities such as curriculum design. Moreover, a good school facilitates collaboration among students instead of competition so students learn to grow together and help each other, not how to succeed at the expense of other students.

Fostering an informal learning community at school fits the characteristics of a good school and makes it a better school.

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Table 1 Sample techniques of a web site to foster the informal learning community

Goals of the Informal Learning Community	Sample Techniques in Designing the Community Web Site
Support students to collaborate on real life projects	- Integrate meeting notes into threaded discussion - Provide discussion forum for each project - Provide project templates to help students strategize project process and manage the projects
Encourage peer help with technology learning	- Make the discussions of the project available not only to the community members, but also to other school students - Enable school students who are not involved in the project to leave comments on the project discussion forum - Use projects-centered design for web content instead of technology-oriented design (e.g., technology projects as sections vs. technology jargons as sections for discussion forum) - Provide community discussion forum with different sections - Acknowledge those who have helped other students a lot in the community
Encourage teachers to work with students as teams	- Allow learners anonymity - Provide a specific place for teachers to propose project ideas related to the teaching needs
Create and Maintain Connections with the School and the Local Community	- A link to the web site from the school's web site - Acknowledging the help from school staff members on projects - Provide a repository of connection for learners to store and retrieve connection information

Implementing virtual collaborative inquiry practises in a middle school context

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The aim of the study was to investigate the challenges that relate to the implementation of virtual inquiry practises in middle school. The case was a school course in which a group of Finnish students (N=14) and teachers (N= 7) completed group inquiries through virtual collaboration, using a Web-based learning environment. The task was to accomplish a cross-disciplinary inquiry into cultural issues. The students worked mainly at home and took much responsibility for their course achievements. The investigators analysed the pedagogical design of the course and the content of the participants' interaction patterns in the Web-based environment, using qualitative content analysis and social network analysis. The findings suggest that the students succeeded in producing distinctive cultural products, and both the students and the teachers adopted novel roles during the inquiry. The Web-based learning environment was used more as a coordination tool for organizing the collaborative work than as a forum for epistemic inquiry. The tension between the school curriculum and the inquiry practises was manifest in the participants' discussions of the assessment criteria of the course.

Keywords: Progressive inquiry learning; Virtual learning; Collaborative knowledge building; Pedagogical design; Pedagogical innovation; Middle school

AMS Subject Classification: ?

1 Introduction

In recent years, the new possibilities of modern Web-based technologies have generated expectations of profound changes in education. According to these expectations, technology can transform school learning, e.g. by providing easy access to information and real-world problems, new means for communication and collaboration, and tools for developing higher-order thinking and knowledge management skills (Bransford *et al.* 2000, Roschelle *et al.* 2000, Hofer 2004). These expectations stem from beliefs that the future knowledge society requires competencies that develop only through participation in the collaborative practises of working with knowledge and solving authentic problems of understanding (Scardamalia and Bereiter 1999, Hakkarainen *et al.* 2004).

According to several studies (Dexter *et al.* 1999, Lim and Barnes 2002, Windschitl and Sahl 2002), a technology, as such, does not automatically change educational practises; teachers' deliberate effort to develop the learning culture is also needed. Previous experiences (Smeets and Mooij 2001, Salomon 2002) have shown that modern technology is often assimilated into the prevailing educational philosophy and practises, and the affordances of technology are not fully exploited to change the quality or nature of education.

Recent studies, however, have also reported promising examples of emerging, innovative ways of using information and communication technology (ICT) to change teaching and learning practises in schools around the world. Based on the examination of 174 case studies, Kozma (2003) listed the following features that characterise innovative classroom practises in which technology has been used to change pedagogy: the usage of ICT is integrated into the curriculum; students work collaboratively and use ICT to search for information, publish results and create products; and teachers change their role from delivering knowledge to organizing, guiding and assessing students' learning processes. Kozma concluded that "when students also use technology to conduct research projects, analyse data, solve problems, design products, and assess their own work, students are more likely to develop new ICT, problem solving, information management, collaboration, and communication skills" (p. 13). In order to better understand the possibilities and challenges of transforming school education with technology, such cases of advanced and innovative pedagogical practises should be the object of detailed scientific examination.

The present study examines a case in which teachers seriously strove to develop their educational practise with technology, embedded in a meaningful pedagogy and new ways of working with students. The pedagogical setting had several features that may be described as innovative (Kozma 2003), which was the reason why it was chosen for investigation. Several teachers participated in the planning and implementation of the investigated course, and they had an ambitious goal to get middle school students acquainted with the practises of inquiry learning and distance working mediated by Web-based technology.

2 Progressive inquiry learning

The pedagogical approach that the teachers applied in the investigated case was *progressive inquiry learning* (Hakkarainen 2003, Muukkonen *et al.* 2005), a term meant to characterize a sustained process of advancing and building knowledge characteristic of scientific inquiry, in this case, with the support of Web-based technology. The aim is not merely to achieve content mastery; a parallel emphasis is on skills in solving problems and constructing new knowledge, which resembles the practises of expertise and teamwork.

Bereiter and Scardamalia (1993, Scardamalia and Bereiter 1999) proposed that with the support of appropriate technologies, schools should become knowledge-building organizations, in which students and teachers participate in the construction of collective knowledge, and the primary goal of activity is not individual learning, but solving of authentic knowledge problems. The progressive inquiry approach shares with the knowledge-building approach an assumption that inquiry is seen as a process mediated by shared *knowledge objects*, such as questions, explanations, plans, and ideas (Bereiter and

Scardamalia 1993, Paavola *et al.* 2002). Also in the theoretical background for the progressive inquiry model is the interrogative model of Hintikka (1999), which emphasises the important role of explanation-seeking questions in the processes of creating knowledge.

The progressive inquiry model concretises the collaborative knowledge-creation process by specifying some essential elements for epistemological advancement (Hakkarainen *et al.* 2004). The starting point of a progressive inquiry process is the creation of the context for inquiry by presenting a multidisciplinary approach to theoretical or real-life phenomena. The students are guided to form their own questions about the phenomena and create their intuitive working theories as explanations to answer the questions. These stages are undertaken before using authoritative information sources, to challenge the students' own thinking. The learning community acquires new information by exploiting various information sources after having together evaluated the produced ideas and explanations. The process will be repeated gradually with deepening cycles of formulating subordinate study questions and more accurate theories and knowledge products. The model is not meant to be followed rigidly, but it offers conceptual tools to discuss, organize and make visible the strategies and activities in the inquiry practise.

Essential for the advancement of a progressive inquiry process is that all knowledge objects and the phases of the process are shared within the whole learning community. Web-based technology, when properly designed, supports the progressive inquiry process by offering a virtual space for collaboratively sharing and elaborating knowledge objects, offering a basis for multiple perspectives and idea development, or providing external representations for ideas that can be referenced in collaborative discourse (Muukkonen *et al.* 2005, Suthers and Hundhausen 2003).

The progressive inquiry model is applied, tested and developed at many schools and universities in Finland (see Lipponen *et al.* 2002, Lahti *et al.* 2003, Veermans and Järvelä 2004, Muukkonen *et al.* 2005). Our recent studies (Lakkala, Lallimo *et al.* 2005, Lakkala, Muukkonen *et al.* 2005), especially, have addressed the following crucial issue: if we educators want to understand the challenges and problems in implementing progressive inquiry pedagogy in authentic educational settings, it is important to take into account the overall organisation of activities and social practises, in addition to the participants' epistemic activity during the process.

3 Virtual collaboration

In addition to the progressive inquiry approach, another special feature in the investigated case was the organization of the course partly as a distance learning setting: the students worked mainly off the school premises and communicated with each other, and with teachers, from home through a Web-based learning environment in addition to face-to-face meetings. In this article, we use the term *virtual collaboration*, meaning that the participants, while working, are physically and temporally dispersed, and the interaction between them is mediated by technology (Watson-Manheim *et al.* 2002). The introduction of Web-based technology in educational contexts raises the possibility of extending the collaborative learning activities beyond the school walls (Ligorio *et al.* 2005). Usually the studies of technology-enhanced inquiry learning at middle school level come from face-to-face classroom situations (Lamon *et al.* 1996, Salovaara and Järvelä 2003), whereas virtual collaboration settings have been studied mainly in university-level education (Guzdial and Turns 2000, Schrire 2004, Muukkonen *et al.* 2005).

Wegerif (1998) stated that a sense of community appears to be a necessary pre-condition for collaborative learning to succeed. Even in conventional teacher-led classrooms students have social communication that supports academic content learning, although it is often regarded as 'off-task' behaviour (Granstrom 1996). In the study of Hogan *et al.* (1999) that investigated the content of 8th grade students' face-to-face group discussions in a problem-solving task, one fourth of the group communication was about the logistical or concrete aspects of the task, and about 10% was regarded as off-task conversation.

If the participants are collaborating virtually, the challenges of organizing the learning community can be compared with the challenges of building virtual communities in general (Barab, 2003). Elements that characterise successful virtual communities are, e.g. shared goals and resources, active participation and reciprocal interaction, sense of belonging, trust in others, and the shared context of social conventions (Schuler 1996, Preece 2000). The features and affordances of the Web-based tool used for collaborative activity have, naturally, important effects on the realisation of virtual collaboration (Kirschner *et al.* 2004). In the investigated course, the students and teachers used a Web-based learning environment where the main collaborative tool was a quite typical, threaded discussion forum. The same kinds of forums are widely employed in learning situations (Guzdial and Turns 2000, Schrire 2004) because they are easy to use and apply, but they do not include any special tools or support for virtual inquiry, such as awareness tools or built-in cognitive scaffolds.

4 The purpose of the study

As Kozma (2003) stated, the positive impact of technology depends on how teachers implement technology in their pedagogical practise. Another important variable in success is the role of the institutional practises and structures of the school system in the implementation of new pedagogies (Hannafin and Land 1997, Dexter *et al.* 1999, Roschelle *et al.* 2000). Engeström *et al.* (2002) in their study of school change proposed that there are deep structural constraints on developing the school: Socio-spatial structure of the school work (separate classrooms, teachers working alone, the isolation of the school from the environment), temporal structure (discrete and short lessons, test and grading phases), and motivational and ethical structure (grading as the main motivational method). Bielaczyc (2001) stated that the central challenge in implementing knowledge-building pedagogy in schools lies in creating the appropriate *social infrastructure* around the technology implementation, such as classroom culture and norms established, classroom practises and online activities in the process, and the use of the technological environment.

Agreeing with Candela *et al.* (2004), we believe that in order to understand the challenges, obstacles and successes that teachers face in implementing modern technology and related pedagogical innovations in classrooms, detailed analysis of interaction processes should be undertaken within the larger structures of activities and lessons, and within the institutional and social context. The purpose of the present study is to investigate the challenges that relate to the implementation of virtual, collaborative inquiry practises in a Finnish middle-school teaching group. Based on the above review, the research questions are the following:

1) How did the original goal of progressive inquiry pedagogy become actualised in the investigated course?

2) What was the role of the Web-based learning environment in the inquiry process, and what kind of interaction patterns emerged in the participants' virtual collaboration?

3) How did the pedagogical approach fit with the curriculum and institutional practises of the middle school, and what were the effects, if any, of such fit or lack of it?

5 Research methods

5.1 The context of the study

The evaluated course was organized in a regular middle school in the city of Helsinki. The school has a long tradition of participating in school development projects and collaborating with educational researchers. It has a reputation of an experimental school: E.g. it is the only middle school in the city of Helsinki with non-graded instructional groupings; the teachers regularly take part in pedagogical development work promoted by the principal, and some teachers participate actively in ICT projects (Ilomäki *et al.* 2004).

The design of the 'Culture course' was first created during an educational technology project examining the usage of portable computers; participation in the project helped the school to increase its ICT resources, among them teacher training (Sinko and Lehtinen 1999). By conducting the Culture course, the teachers of the school wanted to create a pedagogical practise that would give students a special experience before completing their compulsory education; the course has now been established as a permanent practise that is repeated every spring.

At the time of the course, the school participated in the Educational technology project of the City of Helsinki (see Ilomäki and Lakkala 2003). One aim of the technology project was to support schools in implementing Web-based technologies and virtual learning practises in their everyday teaching, which also related to the national goals of advancing virtual learning on all levels in Finnish schooling (Ministry of Education 1999). In the evaluated course, the teachers' intention was deliberately to surpass the limits of classrooms, subject domains and short-time lessons, but the teachers still acted in a conventional school context with no extra resources or changes in the official curriculum.

5.2 Setting and participants

The Culture course was organized under a very wide multidisciplinary theme of cultural issues, and it integrated students' work in several subject domains and school courses. The setting was also atypical in that several teachers from various subject domains took part in each group inquiry, jointly carrying out the pedagogical planning and the guidance and assessment of students. The teachers defined the following goals for the Culture course: to deepen the students' conception of culture, to give them an opportunity to experience distance learning and to introduce the students and the teachers to the progressive inquiry approach.

The progressive inquiry model was new to most of the teachers, so they were in novice roles themselves although the initiative to carry out such a course came from them. When the teachers introduced the progressive inquiry approach to the students, they explained it to be question-driven inquiry, which is structured in certain phases, and which emphasises students' own planning and self-regulated work, sharing of knowledge, and mutual commenting and feedback. The students were encouraged to produce an innovative cultural product as a final piece of work of the course, not just a traditional project report.

The students decided the actual topic of their inquiry among themselves. The final products could take several forms: for example, as a research report, a slide show, a radio play, a wall newspaper, or an artefact exhibition.

The actual course period lasted seven weeks, from February to April, but the whole process started two months beforehand with some preliminary meetings. The students worked mainly off the school premises during the course. There were seven common meetings at school, otherwise the students communicated through the Web-based learning environment from home or arranged face-to-face meetings with their small group members and the guiding teachers. The final pieces of work, in particular, were constructed mainly in face-to-face group meetings that the students themselves voluntarily arranged, although the teachers encouraged the students to use the Web-based learning environment for knowledge sharing and communication.

The technology used in the course was a Web-based learning environment called Virtual Web School (VWS), designed by the Media Centre of the Helsinki City Department of Education. The main tool for organizing the participants' virtual inquiry was a typical threaded discussion forum. The learning environment also included a chat tool and a text-based portfolio for students' private products, but they were not in active use during the course. It was not possible, for instance, to share documents through the VWS.

The course had 14 student participants, aged 15-16, and 7 teachers, representing computer science, biology and geography, religion, history and philosophy, arts, music, and Finnish language. The students volunteered to participate in the course; they did not belong to a traditional classroom community, but were gathered together especially for this course. They were all quite high achieving students (according to the teachers), and they were meant to complete several, regular school courses by participating in the Culture course. It was the students' last spring in the obligatory comprehensive school. The teachers did not participate full-time in the course; they were responsible for other school courses as usual. The computer teacher was a coordinator of the whole course; other teachers participated as the experts and tutors of their own subject domain.

5.3 Data collection

The main data analysed in the study included the database notes posted by the participants to the VWS discussion forums during the course. The material was retrieved for analysis so that all the posted notes were arranged in a hierarchical order based on the reply structure; the first notes of each thread were listed in chronological order. The course was in Finnish; therefore, all the text examples presented in the article have been translated into English.

Five (out of seven) joint meetings in school were observed and videotaped by the researchers. One researcher participated in two teacher meetings, where the teachers designed the course. In addition, the researchers received various documents about the course accomplishments, including final works and written course evaluations from the teachers. This material and observational data from the meetings were used in complementary fashion to obtain an overview of the work process and to interpret the communication in the Web-based environment in a larger context.

5.4 Data analysis

The methodological approach in the study was to answer the research questions by using rich qualitative data: database material, authentic documents and observations in the classroom and teacher meetings. There was no single piece of data or analysis that could exhaustively answer any question; rather, the results of separate analyses were combined to yield a multifaceted view of the virtual process from various perspectives.

Several quantitative measures of the features of the virtual discourse — number of messages, the distribution of messages in time and in the various forums, and length of discussion threads — were applied to the discussion forums in the VWS, in order to get an overview of the study group's virtual activity during the course.

The contents of the messages to the VWS database were analysed qualitatively using the methods of *qualitative content analysis* (Chi 1997) to evaluate the communication in the virtual discourse. The unit of analysis was one message. Messages were categorised according to the main content of the message text: what appeared to be the main purpose or object of the message in the discourse. The categories were derived from several preliminary analyses of the data in relation to the research questions. The following five categories were used in the final classification (examples of messages belonging to each category are reported in the Results section):

1) *Subject of inquiry*: These messages represented the students' problems, thoughts and explanations of the inquiry topics and subject domain concepts, descriptions of the subject of their inquiry, and the teachers' subject-specific guidance.

2) *Process organization*: Messages in this category included communication that was needed for organizing the work of separate small groups (arranging meetings, asking for help or comments, telling about information sources, making the agreement for task completion).

3) *Community building*: Messages in this category represented issues concerning the whole group, such as general discussion relating to the common purpose of the whole group (e.g. practising progressive inquiry and collaborative work, accomplishing inquiry about cultural issues), communication about the ways of using the virtual tools (e.g. organizing the forums, advice to use sensible message titles), and social aspects of the work (the need for a common meeting room, invitations and encouragement to participate actively in virtual work).

4) *Assessment criteria*: Messages in this category included questions, agreements and arguments about the rules for completing the final work, criteria for course grading and general timetables or deadlines.

5) *Other issues*: Messages put into this category included conversation about topics or school activity unrelated to the course tasks, and nonsense test messages written by the students in the practising phase.

Each message was classified in only one category according to its main content. The analysis was performed using ATLAS/ti-program. To analyse the reliability of classification, an independent coder classified approximately 17% of all messages (randomly selected message threads from a general forum and all the messages from one group forum); the coefficient for coder agreement (Cohen's Kappa) was .85, which was considered satisfactory. Those cases in which discrepancy emerged were encoded according to mutual agreement.

Methods based on *social network analysis* (Scott 1991) were used to study the structures of communication in the virtual activity, using the discourse data that consisted of the links between the messages: who communicated with whom by constructing message replies in the VWS discourse forums. The same methods have been used also in other studies of technology-supported collaborative learning (Lipponen *et al.* 2002, Hakkarainen and Palonen 2003) or in teachers' communication networks in a school (Bakkenes *et al.* 1999). All social networked analyses were performed using the Ucinet program.

The multi-dimensional scaling (MDS) technique was chosen to provide a graphical view of the communication patterns. The basic idea behind MDS is that of using the concepts of space and distance to map relational data. It includes an attempt to convert chart measures into metric measures (Scott 1991).

The participants' position in the virtual communication was analysed using Freeman's degree, which is a centrality measure. Centrality describes the importance or isolation of a member in the communication network. The degrees were counted from the sum of replies that the participants sent to others' messages (outdegree, indicates activity), and replies that the participants received from others (indegree, indicates 'popularity') in the VWS discussion forums. Freeman's betweenness value was used to show how often a given participant is found in the shortest path between two other students who do not directly interact with each other. Thus, it suggests the participant's position in regulating information flow within the communication network (Borgatti *et al.* 1996).

The measure of density was used to evaluate the general level of communication in the virtual discourse. Density is a simple way to measure a network: the more actors who have relationships with one another, the denser the network (Scott 1991); hence it indicates, here, the proportion of the intensity of interaction among the participants in the VWS discussions. Density was computed from a dichotomised matrix of replies (the participants had or had not sent replies to each other's messages, the frequency of replying did not matter) and it could vary from 0 to 1. The density of the communication in the whole study group was counted both with and without the teachers' contributions in order to analyse the teachers' influence on the communication.

One methodological challenge was to combine the quantitative and qualitative measures to obtain a richer view of the collaboration structures in the virtual discourse. For that, we made separate matrixes for the sum of replies in each content category (Subject of inquiry, Process organization, Community building, Assessment criteria and Other issues) in the VWS, in order to find whether the centrality of the participants varied according to the content of the discourse. The degree measures were also used to examine the extent to which a whole graph representing participants' communication in VWS had a centralised structure or was distributed evenly through the whole network (Scott 1991).

6 Results

6.1 The course design

The overall actual, patterned process of the course – the structure and phases of the activity during the course – was reconstructed by combining the information received from the examination of database content, observed lessons and the teachers' planning sessions. Below is a short description of the main phases of the course.

Preliminary phase: The whole process started in the middle of December with a 1½-hour meeting in the school, when teachers introduced the course and its objectives to the students. Some students seemed to be insecure about the requirements of the course. Four high-achieving girl students withdrew from it in the first meeting. They stated that it is 'safer' to work in traditional courses because they wanted to get the highest degrees to their final middle school report. In the middle of January, the computer teacher gave the participants a training session for the VWS-environment. All students seemed reasonably competent in using technology and the virtual discussion tools. The reasons for using the collaborative tool were also discussed, and the general forum entitled 'Small talk' was founded for practising. The teacher gave the students a task to write their individual inquiry ideas to the VWS forum entitled 'Working plans and starting theories' before the next meeting. At the beginning of February, the philosophy teacher arranged a brainstorming session in the school. Students sketched the content of their inquiry work in the framework of various cultural dimensions (past-present-future, fact-fiction, individual-community, and so on). Also discussed were decisions about the small groups, tutoring teachers and school courses that the students would complete. After the meeting, the students continued the planning virtually in the VWS.

First course week: The students started their actual course work in the middle of February. In the first week, the computer teacher gave a lecture about progressive inquiry by introducing the successive elements of the inquiry process with a graph adopted from the researchers, depicting the following components: Setting up research questions, Constructing working theories, Critical evaluation, Searching deepening knowledge, Generating subordinate questions, and Constructing new working theories (see figure 1). The students formed small groups based on their interests and plans expressed in the VWS and the school courses they would complete. After forming the groups, the students decided the topic of their group's inquiry. The students formed 7 groups and formulated the following research topics: The biological effects of music (2 boys), Life in the Middle Ages (2 boys), Effects of genes and environment on a Finnish-Australian girls' life (2 girls), Japanese culture (1 girl alone), American Indian culture (2 boys), Comparison of Finnish and Canadian cultures (2 girls) and Aspects of religion and society (3 boys). Each group had a main, tutoring teacher, but all the teachers were meant to guide all students and give support especially to those students who were completing courses in their teaching subject. The students had chosen 2-6 school courses that they would complete by participating in the Culture course. At the end of the first week, the students had another working session in the computer lab. Their task was to write their group's research questions and first theories, and comment on other groups' plans in the VWS.

[Insert figure 1 about here]

From 2nd to 6th week: During the next five weeks, the students worked virtually and organized their group processes using the VWS. The students were guided to start the investigation of their research questions. Specific discussion forums for virtual planning were founded for each group, but they were open for everybody. During these weeks, the students processed their work in their respective group forums but also discussed issues in joint forums. In addition they had face-to-face meetings with their own group and the tutoring teachers.

7th and 8th week: During the seventh week (at the beginning of April), there was a common face-to-face meeting where the groups commented on the state of each other's work. The teachers guided the students to think about the main points and new, interesting aspects in each group's inquiry. After that day, the small groups continued their process virtually, mostly finishing their final work and making plans about how to present it in the closing event. During the last week, there was a 4-hour closing event in the school meeting hall, where each group presented its final work in its own way. For example, the Middle

Ages group had made a radio play, and the Canada group had written an imaginary diary of a schoolgirl who was visiting Canada as an exchange student. At the end of the week, the students were called to school, once more, to write their evaluation of the course for the researchers. Also the teachers were asked to complete a written evaluation of the course, its processes, its teaching, and students' results, and send it by email to the researchers; these evaluations were received from only three teachers.

In the Culture course, the students received a credit for 61 courses in all, according to the agreements; 4.4 courses per student on average. Based on the written evaluations, the students were content with their experience of virtual, collaborative learning, which forced them to practise self-direction and independent work. Some students criticised the vagueness of guidance given by the teachers, especially in the beginning of the inquiry process or related to the assessment criteria. The technical problems with the Web-based learning environment were the most-often-mentioned negative issues in the students' evaluations. The three teachers who completed the written evaluations mentioned the shortcomings in the structuring of the inquiry process and challenges of guiding the students during the virtual working periods. One teacher noted that the teachers themselves had different conceptions of progressive inquiry pedagogy.

6.2 The extent and threading of the virtual discourse

The participants posted 534 messages to the VWS database during the course (the minimum was 3 messages of a boy student; maximum, 81 messages of a male teacher). The students (N = 14) posted 308 messages (Mean = 22.0, SD = 29.9), and the teachers (N = 7) posted 226 messages (Mean = 32.3, SD = 26.0). The joint forum entitled 'Small talk' included 168 messages; the 'Plans and theories' forum, 113 messages; and the seven, group forums included 253 messages in all. In figure 2, one can see how the volume of messaging varied in discussion forums during the course.

[Insert figure 2 about here]

At the beginning of the process, only the two general forums were in use. As figure 2 shows, in the first, course week, the work was concentrated in the 'Plans and theories' forum according to the teachers' instructions. After the second week, the communication was mainly transferred to the group forums, where it was the most active in the middle of the course.

In all the virtual forums together, there were 218 top-level messages (41% of all messages), those considered to be new initiations in the discourse. Of such messages, 44% (97) were isolated messages that did not have any replies following, and 56% (121) were messages that had at least one reply; e.g., they had started a new discourse thread. The mean number of messages in discourse threads (in the threads that included at least two messages) was 3.63 (SD = 2.15). The longest thread included 14 messages, and only three threads had more than ten messages.

There were big differences in the use of each group's forum. The minimum number of messages in one forum was 13; maximum was 56. The mean number of messages in all group forums was 38.2 (SD = 14.9). We also counted the number of messages that the students sent to the forums of other groups. Only 8 (out of 253) messages in the group forums were written by students from some other group. The students, clearly, did not contribute to other groups' inquiry work after the group forums were founded although they have been encouraged to do so (a notice from a videotaped lesson).

6.3 The content of the virtual communication

In the analysis, each message to the VWS discourse forums was assigned to one of the content categories described earlier. The original goal of the investigated course was to use the Web-based learning environment to support the sharing of knowledge during the inquiry process, which involves sharing the theories and explanations of cultural aspects. According to the content analysis, only 34% (180) of the messages could be assigned to represent the Subject of inquiry category. The frequencies of other content categories were as follows: Process organization messages 24% (129), Community building messages 20% (105), messages about Assessment criteria 13% (67), and messages about Other issues 10% (53).

The separate discourse forums obviously played several roles in the virtual communication. In the 'Small talk' forum, 50% (84) of the messages were community-building messages, and about 25% (41) were about other issues, unrelated to the common course goals. In the other joint discussion forum, the 'Plans and theories' forum, 64% (72) of the messages were about the subject of inquiry. In the seven group forums, most of the communication was about the subject of inquiry (42%, 105) or process organization (42%, 107). The content of communication varied remarkably during the successive weeks of the course (see figure 3).

[Insert figure 3 about here]

In the virtual communication, issues that were interpreted as important for building up the learning community were dominant in the first half of the process, as shown in figure 3. The following discourse thread is an example of messages assigned to the category of *community building*; the messages reveal that some students were very competent with technical issues:

> 18.01.2000 14.45.04 About this Culture course (Boy student b8G)
>
> This is a fine system, but ... the possibility for real-time discussion is still missing. Maybe an IRC-channel? For instance #alppila #culturecourse #alppila_culturecourse ... Then we, of course, need a 'bot' program to keep the channel going; does anyone have the possibility to supply one?
>
> Waiting for answers...
>
>> 18.01.2000 14.51.07 We need that later, we are not here all the time (Girl student g5F)
>>
>> It is true that it would be useful because we need conversation, and it's not always sensible to use the telephone. This discourse forum is good, but it will probably be more differentiated; now this functions as a discussion medium. I support your idea!

The number of messages about *other issues* unrelated to the Culture course was high in the preliminary phase, probably because then the students and the teachers were practising their use of the Web-based environment. In the session at school, in which the participants were trained to use the VWS environment, 42% (27) of the posted messages were classified as community building messages, and 32% (21) as about other issues. The teachers did not direct the first practises with the VWS to subject-related inquiry work (a notice from a videotaped training session).

The number of messages in the *subject of inquiry* category was the largest in the first week of the course period, when the students were guided explicitly to define their plans, questions and first theories in their postings to the discourse forums. The following thread is an example of subject-related discourse:

> 17.02.2000 19.37.53 Problems, group A (Boy student b9G)
>
> 1. How have the different cultures affected the development of humans?
>
> 2. How have the cultures spread out in the world and how have they affected each other?
>
> 3. Collaboration with Thomas:
>
> What were the basic differences between the culture of American Indians and the western [European] culture?
>
> What caused the disappearance of Indians?
>
> How did the Indians' nature-based culture work?
>
> 4. What is the Islamic culture actually like? Is it as bad as the media represent it?
>
>> 18.02.2000 13.46.40 A comment (Boy student b7E)
>>
>> Good start, just continue!
>>
>>> 18.02.2000 13.43.31 Large topics... (Girl student g5F)
>>>
>>> Large topics... good topics... the effects of cultures on human development, you should consider what things to examine... the appearance, the ways of life, the economic state, environment... it might be difficult to examine everything.
>>>
>>> Effects on each other or the spreading... a very good topic, but it is quite difficult, at least those effects... should you examine some special culture?
>>>
>>> Indians... on the other hand, if you have these large topics also, that topic is quite restricted to a certain place and it is also a small one... but it is also interesting.
>>>
>>> About that Islamic religion I cannot say much.

Especially later in the course, most of the messages assigned to the Subject of inquiry category were about shaping the content of the final work. The following is an example of the message from the Australian group:

> 23.03.2000 11.09.22 Answer Sorry, if...(Girl student g1B)
>
> ... sorry that we did not discuss [things] with you, before the course, including the topics of religion in our work. But we have a lot of material about that topic. First we are going to tell about the religion of aboriginals, totems and 'dreamtime' and its myths. In addition we are going to compare their attitudes towards life with ours, and to examine how they experience our religion and our God. We thought also to include something about Jesus...

The teachers' subject-related messages were mostly guidance for the inquiry process. For example:

> 29.02.2000 08.39.28 I want information (Male teacher M1D)
>
> Do you remember that I asked the other day for a list of your beliefs and conceptions about the Middle Ages. I thought that BEFORE you start to read Litzen's book etc., you

should write your conceptions about what the Middle Ages are, either as a mind map or as an idea list. It can be a quite long list. Is Xena medieval? What about Conan? You understand the usefulness of this, don't you? Don't be afraid of possible 'mistakes' – in this work you cannot make them.

According to the analysis, very little of the subject-specific discourse was of a high-level conceptual nature or contained proposed theoretical explanations; rather there was reporting or commenting on the themes under examination. It appears that the students and the teachers did not actually use the Web-based environment very much as a forum for collaborative knowledge building or for the sharing of knowledge productions. Most of the knowledge construction, to the extent it occurred, probably happened in face-to-face meetings with the group members and the tutoring teachers, not through the VWS. Participants might also have used e-mail or a chat forum for mutual communication inside the groups, but such information was not available for the researchers.

In the VWS discourse forums, the number of *process organization* messages increased after the small groups were formed, and it continued to increase towards the end of the course. Many of the process organization messages handled daily, practical matters, such as arranging meetings or explaining activities to be done. The planning of the groups' presentation in the closing event was one dominant theme in these messages. The following thread is an example of process organization discourse in the Music group:

09.03.2000 17.09.11 How are you (Female teacher F2B)

What is the situation in the research about the biological effects of music, or are you still planning it? Regards, Susan

09.03.2000 22.48.04 Thanks, very well...(Boy student b2A)

We have started the research, but because Mike got sick during our music activity, we had to stay in the same phase for a while.

13.03.2000 10.32.44 Sharing the work (Female teacher F4F)

Would it be useful to share your work, so that if the one is sick, the other can somehow continue the work before the time runs out.

Toward the end of the course, questions about *assessment criteria*, such as timetables, rules and course evaluation started to interest the students more, and it appears to be one of their concerns that the criteria had not been clearly specified in the beginning of the process. The original goals of the course had been to promote multidisciplinary inquiry, but towards the end, the teachers and the students had to enter into agreements about course completion according to the curriculum. One of the longest and 'hottest' discourse threads (12 messages) in the Web-based environment was about assessment criteria and deadlines for the work. For example, one girl student had problems with understanding the idea of getting comments and revising the work:

30.03.2000 08.03.12 Returning the work (Male teacher M1D)

Well, simply: You bring, on the 5th day of the month, the work you have. Some groups may be so ready, that nothing can be added to the work. Most of the works consist of several parts. Perhaps, at least some parts could possibly be improved? Maybe there is something to add, or to correct? Why do you think that you cannot change the work that has been returned? This is not a final exam. Peter

01.04.2000 16.06.18 It cannot be changed, and that's it! (Girl student g1B)

Our work is either ready, or then it is not. It is a sound whole, a narrative, and there are two options: either we return it as a whole or we don't return it at all.

Two girl students even refused to come to the evaluation meeting after the course because they had not yet come to an agreement with the teachers about their course grades (information received from the teachers). There was an obvious contradiction between the traditions and demands of the assessment practises in school and the new goals of virtual, collaborative inquiry work.

The evaluated course gave a good opportunity to compare students' and teachers' contribution to a collaborative inquiry process because there were so many teachers involved in comparison to the number of students (although some teachers' contribution to the virtual discourse was rather small). In table 1 are presented the general frequencies and proportions of each content category in the students' and teachers' messages. The general content profiles did not differ much (the correlation of the distribution was 0.71). According to $\chi 2$-test there was a significant difference between the groups ($\chi 2 = 26.8$, df = 4, $p<0.001$). Cell-specific exact tests were carried out in order to examine whether the observed frequencies in each cell deviated from what could be expected by chance alone.

[Insert table 1 about here]

The results of table 1 indicate that both the teachers and the students took responsibility for the virtual work. A quite expected result is that the students had more messages than teachers, on other than course-related issues. What is noteworthy is that the teachers used the Web-based environment a great deal for supporting the students' process organization, in addition to providing advice related to the subject of inquiry. Another indication of the teachers' strong efforts to organize the group work through the Web-based environment was the high proportion of the teachers' messages posted to the small groups' discourse forums. Teachers wrote 57% (145) of the 253 messages in the group forums. The content of the process organization messages in the VWS and other information received from the course indicate that that the students themselves did not use the Web-based environment for intra-group collaboration, but did the actual group work in face-to-face meetings. The Web-based environment was used mainly for sharing issues concerning all participants or for communicating with the teachers.

6.4 Interaction patterns in the virtual communication

Methods based on social network analysis were used to study the patterns of interaction in the students' and teachers' virtual activity. The main measures of interaction activity were numbers of sent (outdegree) and received (indegree) replies. For the students, the average outdegree was 13.4 (SD = 12.27); indegree was 16.4 (SD = 10.54). For the teachers, the average outdegree was 20.0 (SD = 20.8); indegree was 14.0 (SD = 13.27). The measures show that the teachers were, on average, much more active than the students in replying to others' messages.

The density of interaction was counted for the whole study groups' virtual discourse, both with and without the teachers' contribution. The density of the interaction in the whole network was 0.35 (SD =0.48) for asymmetric data, and 0.50 (SD = 0.50) for symmetric (reciprocal) data, which is not very high, but not very low either. The density was almost the same when counted without the teachers' participation, which indicates that the teachers' role was not crucial for the density of the virtual interaction. We also examined the extent to which a whole graph representing members' virtual interaction had a centralised structure. The results of the analysis indicated that the interaction was not very centralised: it was 37% and 21% in the case of sent and received replies, respectively. It follows that the communicative efforts were distributed among a relatively large number of participants, but the sending of replies was more centralised on certain participants than was the receiving of replies.

To examine the nature of interaction patterns in the virtual communication more closely, the results of qualitative content analysis and the measures of social network analysis were combined. Separate reply matrixes were constructed for the five, content categories (Subject of inquiry, Process organization, Community building, Assessment criteria, and Other issues), and network centralisation measures (based on the outdegree and indegree measures) were counted separately for those five, different, content networks (table 2).

[Insert table 2 about here]

As can be inferred from table 2, the centralisation of the network varied substantially in various content areas, and it was low only in the content category, 'Other issues'. Communication, and particularly sending of replies, was very centralised, especially on the subject of inquiry and process organization issues, which indicates that in the virtual communication, there were participants who were active in commenting others' ideas concerning the inquiry task.

The position of each participant in the virtual communication network was also analysed separately. To begin with, a multi-dimensional scaling (MDS) analysis was performed to the discourse data of virtual forums in order to get an overall notion of the interaction positions. Because previous analyses revealed that the students did not much use the group forums for advancing their own or other groups' work, the MDS graph was constructed only from the discourse data of the two, joint forums. The intensity of interaction was used as a measure of closeness: the more replies the students sent to or received from certain participants, the closer they are situated in the MDS map (see figure 4). The analysis is calculated with a symmetric matrix, where received and sent replies are summed up. The stress value, a measure of the quality of the MDS map, was at a satisfactory level (0.132).

[Insert figure 4 about here]

Figure 4 reveals that there appear not to have been any distinguishable subcultures of interaction (there is not any group of members who are clearly separate from others). Two teachers are in a rather central position; other teachers are more on the periphery. Three boy students are in a peripheral position in the interaction graph, but at the centre of the joint interaction, one finds only students.

In table 3 are presented the basic centrality measures of each member in the whole virtual communication, including the group forums (the extent of each member's participation and the sum of sent and received replies in every content network). As can be seen from table 3, the most central and active member varies somewhat according to the content of communication, indicating that the members took different roles in the virtual communication. The most active male teacher (M1D) and two boy students (b8G and b9G) were central in almost every content area of the discourse. One girl student was central, interestingly, in the measures counted from all virtual communication, and in the discourse on assessment criteria and other issues, unrelated to the course goals. Her betweenness measure is rather high in comparison with most other members, which indicates that she commented on some members who did not comment on each other directly in the virtual forums. Three, boy students (b1A, b3D and b6E) were very passive, which is apparent also in the MDS graph (figure 4).

[Insert table 3 about here]

Two teachers in particular (the most active male teacher M1D, and the female teacher, F4F, who was the principal organizer of the whole course) had an active role in discussing process organization issues, and teacher M3G engaged in a great deal of communication on the subject of inquiry issues. Other teachers were not very active contributors to the virtual discourse, which might have followed from the original design of the course: Some teachers' role was to guide students only when needed, related to their domain of expertise.

On the basis of both table 3 and the MDS graph in figure 4 one may conclude that two boy students (b8G and b9G) were especially central actors in the virtual interaction: They used the Web-based learning environment actively in their inquiry work, commented on others' ideas frequently in the joint forums, and participated in the discussions of all content areas. The following is an example of a message written by the boy student b9G as a comment on the inquiry plans of a student in the group studying aspects of religion and society:

> 18.02.2000 13.53.14 More questions …(Boy student b9G)
>
> It would also be interesting to know how various stages of religion affect human activity and thinking, what is the effect of administration in religious life, and also a little bit aside of the topic, what elements are similar in different religions… The effect of religion on language is a very interesting question …

7 Discussion

In the present study, we investigated how middle school students and teachers succeeded in accomplishing a virtual collaborative inquiry. We intended to document the challenges that the teachers encountered in applying the new ways of working and to find indications of emerging, innovative, pedagogical practises. In the following, we discuss both the successes of the pedagogical implementation and the problems and challenges in the course relating to the original goals of progressive inquiry and virtual collaboration. It is worth reiterating that the investigated school course was by no means a typical example of implementing Web-based technology and collaborative practices in school. The results are not easily generalisable because of the highly selective student group and the unusually high teacher-student ratio, but we believe they are suggestive of emerging phenomena in the present situation of massive educational challenge and change.

7.1 Successes in the pedagogical implementation

Generally, the evaluated, school course succeeded in many ways. The theme was genuinely multidisciplinary; several teachers collaborated in the implementation; the Web-based learning environment was in relatively active use; and the virtual working setting gave a genuine reason for the participants to use the technology for communication. The students took much responsibility for their work and completed many middle school courses from several subject domains during the course. The final works of the student groups were large, multidisciplinary and unique cultural products.

The traditional student-teacher roles changed in the virtual communication. The teachers gave up their role as knowledge deliverers, and actually some of the students were the most central actors in the virtual interaction. Those central students acted in an expert-like way, taking responsibility for helping decide issues of shared goals and social conventions in the virtual communication, and commenting on other students' work. Using the terms introduced by Scardamalia (2002), we may say that those students demonstrated *collective cognitive responsibility* in their behaviour.

7.2 Progressive inquiry goals not fully achieved

If the implementation of the course is examined critically against the original goals of progressive inquiry, clear shortcomings can be identified. The features of progressive inquiry and joint knowledge construction were present in the students' work at the beginning of the course when the teachers explicitly directed the students' virtual collaboration towards the formulation of research questions and theories about the cultural phenomena. Later in the course, the students and teachers generally did not use the Web-based learning environment for deepening epistemic inquiry or sharing of knowledge objects; their communication changed towards the organization of practical, task-accomplishment issues within the student groups. Probably the organization of the course in sub-groups that had very divergent topics tended to undermine the emergence of a joint object for knowledge work, which reduced the necessity for knowledge sharing in the whole learning community (Hakkarainen *et al.* 2004). Also the Web-based system used did not have very sophisticated tools for higher-level knowledge building: the main collaborative tool was a threaded discussion forum, which did not allow sharing and modifying of joint digital artefacts.

The activity in the course, as it developed, became more like project-based learning, where the formation of the end product starts to dominate as the object of the work, not the advancement of ideas and solving of knowledge problems (Bereiter and Scardamalia 2003). More attention should have been given to the conceptual and theoretical goals of inquiry in addition to the preparation of the final work. Law *et al.* (2002) reported similar conclusions in their multiple-case study of ICT and innovative practises: The nature of students' efforts and learning outcomes was dependent on whether the students were encouraged to engage in working with ideas and understanding, not with tasks and activities.

The students would apparently have needed more accurate structuring and constant support throughout the progressive inquiry process. The teachers taught progressive inquiry principles to the students by lecturing about the model in the beginning of the course. Further, they mainly emphasised students' own active working and self-regulation without demonstrating exemplary ways to support and direct the inquiry activity during the process, as if they assumed that students would learn the practices just by hearing about them. Perhaps this suggests something about the teachers' inexperience in teaching working practices in addition to delivering content knowledge, especially in secondary-level classrooms. Similar results were reported in our other study (Lakkala *et al.* 2005) investigating eight classroom cases of implementing progressive inquiry in primary and secondary education. This difficulty of instructing and supporting students in self-direction and learning higher-order metacognitive strategies relates to the more general problem of *scaffolding collaborative inquiry learning*, a widely discussed issue in recent educational research: How does one support groups of learners to succeed in tasks too difficult for them without help so that they finally learn to master the skills by themselves and the support can be faded away (Tabak 2004, Lakkala *et al.* 2005, Puntambekar and Kolodner 2005).

7.3 Challenges related to virtual collaboration

The actualisation of virtual collaboration was another interesting element of the course because usually virtual or distance working is not applied at the middle-school level. The student groups did not use the virtual forums for collaboration as actively as we anticipated. There were some technical problems in the functioning of the Web-based environment during the course, but it does not appear that the pattern of virtual work was mainly the result of technical issues. All participants had adequate technical skills to use the Web-based learning environment, and some students turned out to be very experienced in using discussion forums and chat tools. Some students were rather critical of the technical possibilities of the tool, which may be one reason for the relatively low usage of the tool during the virtual working phases.

The great number of messages concerning community-building issues at the beginning of the course indicates the necessity (asserted by Schuler 1996) for participants to come to agreement on the collective work habits in a starting virtual community. Also, the great number of process organization messages, especially in the group forums, indicates that virtual work requires a channel through which the participants can coordinate their joint work; in face-to-face situations, such issues are communicated verbally. In that sense, the virtual communication during the course resembled the patterns of a design process, as in a virtual project by university textile students studied by Lahti *et al.* (2003), where over 20% of students' messages to a virtual learning environment were about process organization.

All students did the final work and received credits from several courses, but some students were very passive in the virtual communication, and the teachers had problems with finding ways to guide them during the distance-working periods. On the evidence, the teachers likewise failed sufficiently to foster the students in bringing together various phases of their inquiry work into the Web-based environment for feedback, notwithstanding the original purpose was to share the ideas and plans virtually throughout the course. The unevenness of the students' participation in virtual work and problems with student guidance are results that have also been reported in other progressive inquiry studies of our research group (Lakkala *et al.* 2005, Lipponen *et al.* 2002, Veermans *et al.* 2005). If the participants had been more low-achieving students, they would have needed even more support and guidance.

7.4 Tensions between progressive inquiry pedagogy and school curriculum

The analysis of the course progression and the content of the virtual communication revealed that there were tensions between the inquiry pedagogy and the institutional practises of the school, particularly as regards curriculum and assessment. Even though the school was advanced in pedagogical development work, practises of this kind were still something special, not normal routine embedded in the entire learning culture of the school. The investigated students had two, demanding, new challenges at the same time: progressive inquiry and virtual collaboration. The course was the first time for all the student participants to work in this way, and it was conducted in the last spring of their 9-year comprehensive school career.

The incompatibility of the new working methods and the assessment criteria of the school system emerged as an important issue. To begin with, some students withdrew from the whole course because they felt uncertain about getting the highest degrees in that way. The time of the course was not ideal for radical experimentation because the students were, understandably, concerned about their grades in the final, middle school report. In addition, in spite of the high-level goals of the course for accomplishing collaborative multi-disciplinary inquiry, the teachers still graded students according to domain-specific courses in the official curriculum. The requirement of individual and domain-specific grading was in contradiction with the goals and criteria of collaborative working, and it drew the students' attention to the grades instead of the ideas and knowledge produced during the inquiry process – an issue whose gravity we and the teachers did not appreciate at the time. Roschelle *et al.* (2000) argued that such mismatch between the focus of assessment and the kinds of higher-order learning supported by technology is one of the greatest barriers in introducing effective technology applications in classrooms. The teachers should have designed the assessment criteria, in agreement with school authorities, so as to ease grade pressure, assuring all who participate actively, a high grade irrespective of the actual product.

8 Conclusions

The evaluated school course showed that it is possible to surpass many structural constraints in the school if the teachers and students are open-minded and willing to try new innovations. However, the transformation of educational practises is not a simple task. The institutional norms of school affect the introduction of pedagogical innovation, and those institutional norms also need to be transformed if one wants to change school education with technology. In general, it is desirable for students to have a possibility to practise new, challenging working methods at school, little by little, without the demands of grading and instant success. Growing up to a modern, knowledge-building culture has to happen gradually throughout whole school life.

Although we may question whether it is reasonable to implement distance-working settings at the middle-school level in general, the self-directed virtual working with Web-based technology as such was apparently not too demanding for the students in the investigated case, regardless of some technical problems. The most difficult challenge for the students –and also for the teachers – appears to have been to understand the epistemic nature of the inquiry process and to find effective ways to implement it. It is essential that one convey that the primary goal of progressive inquiry is to focus on the continuous improvement of knowledge objects (questions, ideas and explanations) collaboratively, not simply production of a final work. As Paavola *et al.* (2002) stated, the promotion of students' knowledge-creation practises requires that the teachers build up – indeed, create – an appropriate *epistemological infrastructure* in addition to the social infrastructure whose importance was proposed *inter alia* by Bielaczyc (2001). 'Epistemological infrastructure' refers to individual and collective attitudes towards knowledge and practices of knowledge advancement.

In the present case, the teachers themselves were novices in undertaking progressive inquiry; it challenged their skills and understanding of knowledge-creating inquiry. The transformation of school education with modern Web-based technology probably requires changes both in the teachers' conceptions of learning and knowledge and their skills in implementing advanced practises. The suitable preconditions for promising pedagogical development with technology include the teachers' deliberate efforts to develop their pedagogical practises, their reflection of those efforts and experiences, and the supportive professional culture of the school (Dexter *et al.* 1999, Ilomäki *et al.* 2004). The teachers' efforts promoted creation of these preconditions in the investigated case, despite the difficulties. It would be fruitful to investigate the subsequent implementations of this pedagogical innovation in the same teacher community.

Although the school was not a typical one, we believe the results are intriguing. The case was chosen as the object of research because of its innovative nature. Schools have to get rid of the conventional model of one teacher teaching a fixed study group behind a closed classroom door, in order to properly answer to the expectations that society sets on the development of schools in the future. We submit that the evidence of present case suggests new models and ideas to the discussion of transforming school education with modern technology and advanced pedagogical practices.

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Table 1. The contents of the students' and the teachers' messages in the VWS discourse forums.

Table 1. The contents of the students' and the teachers' messages in the VWS discourse forums.

Content category	Students (N = 14)		Teachers (N = 7)	
	f	%	f	%
Subject of inquiry	104	34	76	34
Process organization	55*	18	74†	33
Community building	65	21	40	18
Assessment criteria	40	13	27	12
Other issues	44	14	9*	4
Total	308	100	226	100

Note. Significance tests are based on binomial probability estimations (Bergman and El-Khouri 1987);
* = Observed frequency smaller than expected by chance alone ($p < 0.01$);
† = Observed frequency larger than expected by chance alone ($p < 0.01$).

Table 2. The centralisation of the communication networks, based on the different contents of the replies.

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Content of communication	Number of notes	Centralisation of the network (%)	
	f	Outdegree	Indegree
Subject of inquiry	180	79.5	37.5
Process organization	129	80.0	48.5
Community building	105	51.8	41.3
Assessment criteria	67	49.8	44.5
Other issues	53	14.3	30.0

Table 3. Activity and centrality measures for all the members in the virtual communication (g = Girl student, b = Boy student, F = Female teacher, M = Male teacher; the letters A-G indicate the groups). The highest four values are bolded in every measure.

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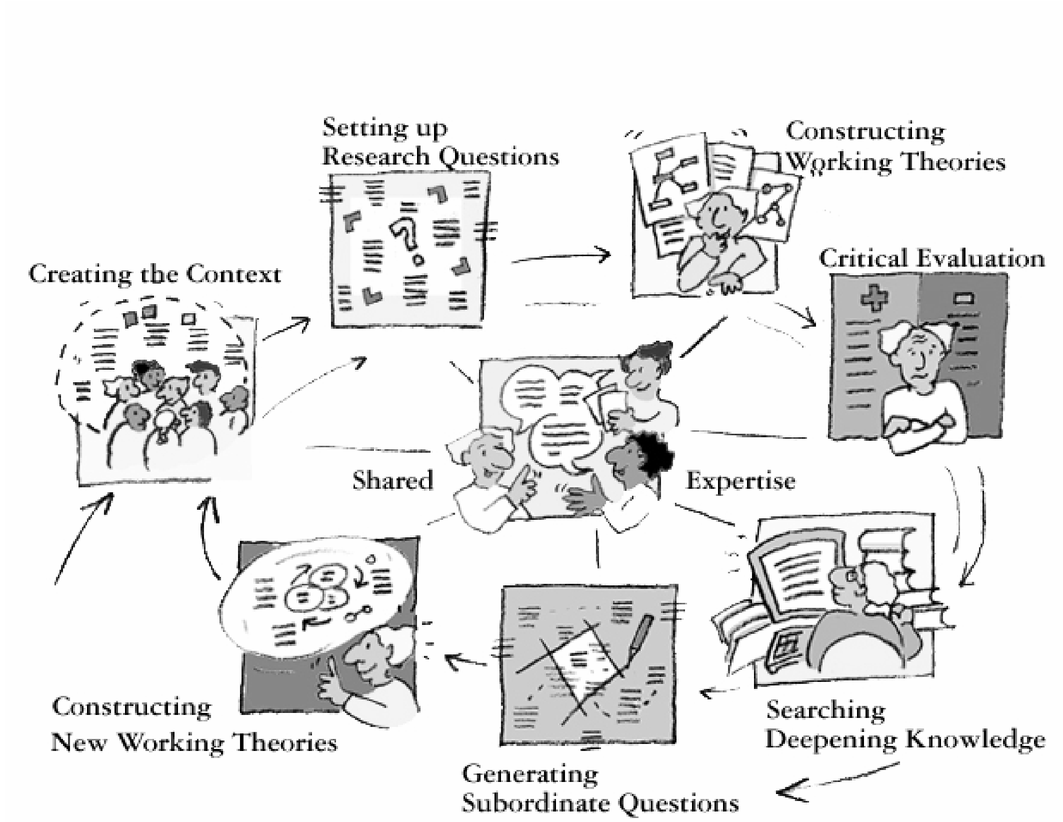
Participant	Overall virtual activity				Sum of replies in each content network				
	Messages written	Sent replies (outdegree)	Received replies (indegree)	Betweenness	Subject of inquiry	Process organization	Community building	Assessment criteria	Other issues
b1A	5	3	2	1.4	3	1	0	0	1
b2A	12	8	10	4.7	5	2	3	0	**8**
g1B	**45**	26	**28**	**13.2**	16	3	6	**21**	**10**
g2B	10	7	6	1.3	3	1	5	0	4
g3C	13	6	16	5.5	9	7	0	4	0
g4C	7	2	12	1.2	9	3	1	0	1
b3D	5	0	6	0.0	5	1	0	0	0
b4D	35	21	23	2.0	14	11	**18**	0	2
b5E	26	11	20	7.0	13	2	12	0	4
b6E	3	0	4	0.4	3	0	0	0	0
b7E	19	11	12	1.5	5	9	2	1	**6**
g5F	38	23	25	6.1	**24**	**16**	5	3	1
b8G	**48**	**31**	**31**	**21.1**	**20**	**14**	**20**	**6**	5
b9G	**53**	**38**	**34**	**13.5**	**33**	**14**	**18**	2	2
F1A	7	1	3	0.7	2	1	1	0	0
F2B	31	9	12	6.5	10	4	3	**5**	0
F3C	10	6	7	0.0	2	1	2	**5**	2
M1D	**81**	**62**	**43**	**8.8**	**33**	**32**	**20**	**12**	**6**
M2E	19	11	9	5.4	6	7	6	1	1
F4F	39	23	10	3.9	13	**18**	1	1	0
M3G	39	**28**	14	5.9	**20**	11	9	3	1
Mean/ students	22.8	13.4	16.4	5.6	11.6	6.0	6.4	2.6	3.1
Mean/ teachers	32.3	20.0	14.0	4.5	12.3	10.6	6.0	3.9	1.4

Figure 1. A graph presenting the elements of the progressive inquiry process.

Figure 2. The number of messages in the separate discourse forums in each course week.

Figure 3. Change in the content of messages in the VWS discourse forums during the project.

Figure 4. The structure of communication in the virtual discourse (g = Girl student, b = Boy student, F = Female teacher, M = Male teacher; the letters A-G indicate the groups).


Setting up
Research Questions
Constructing
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Critical Evaluation
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Expertise
Constructing
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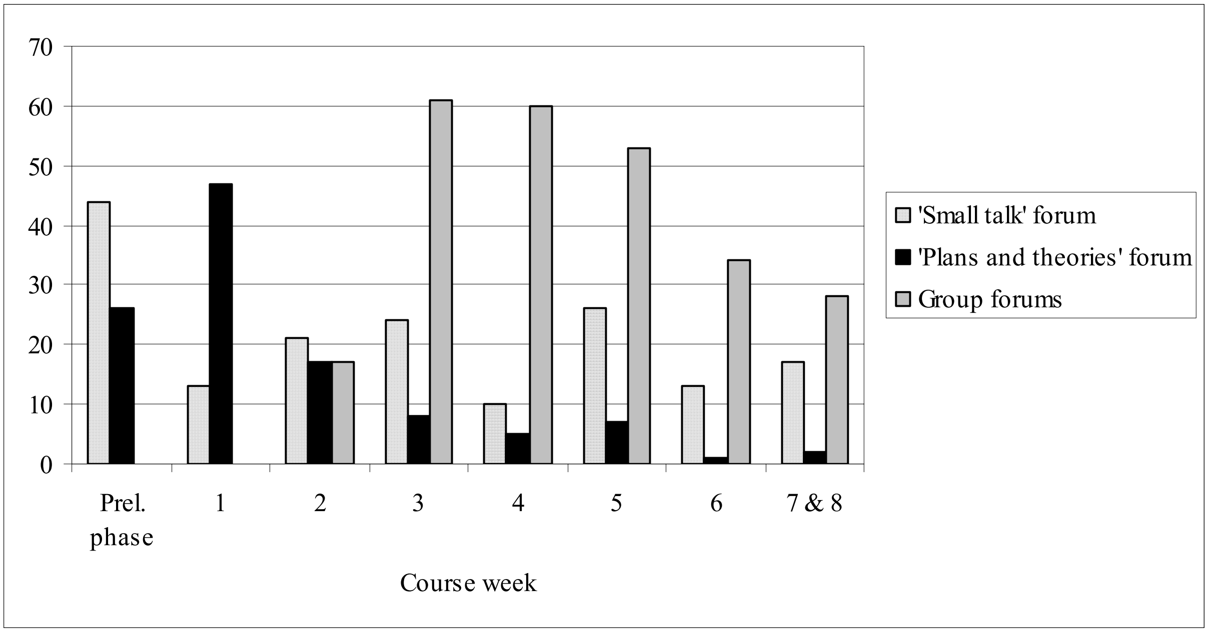
Subordinate Questions
Searching
Deepening Knowledge


70
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Course week
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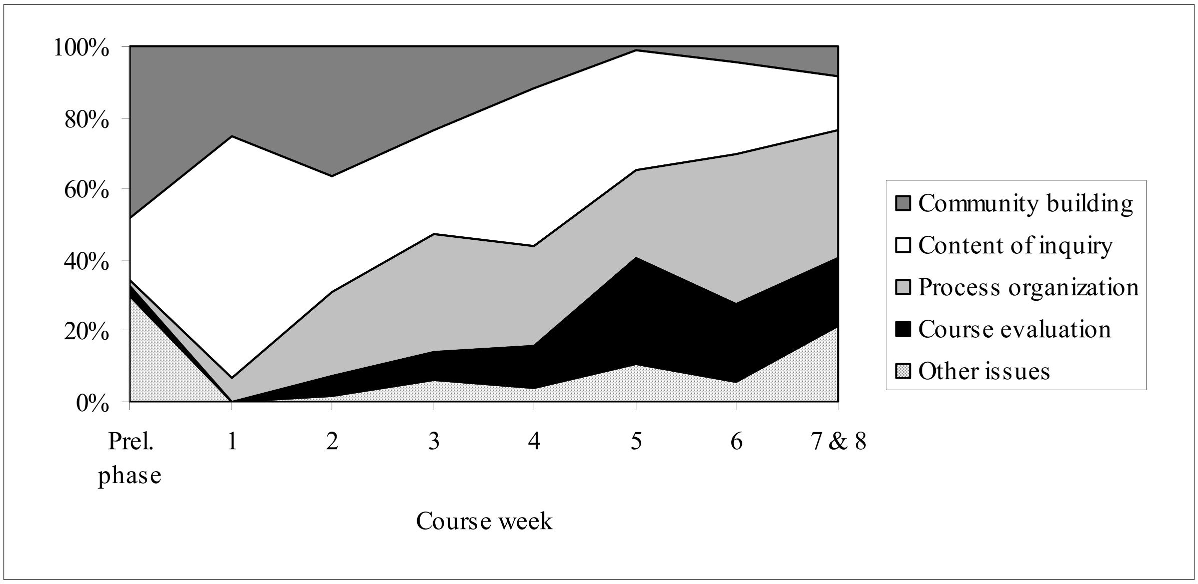
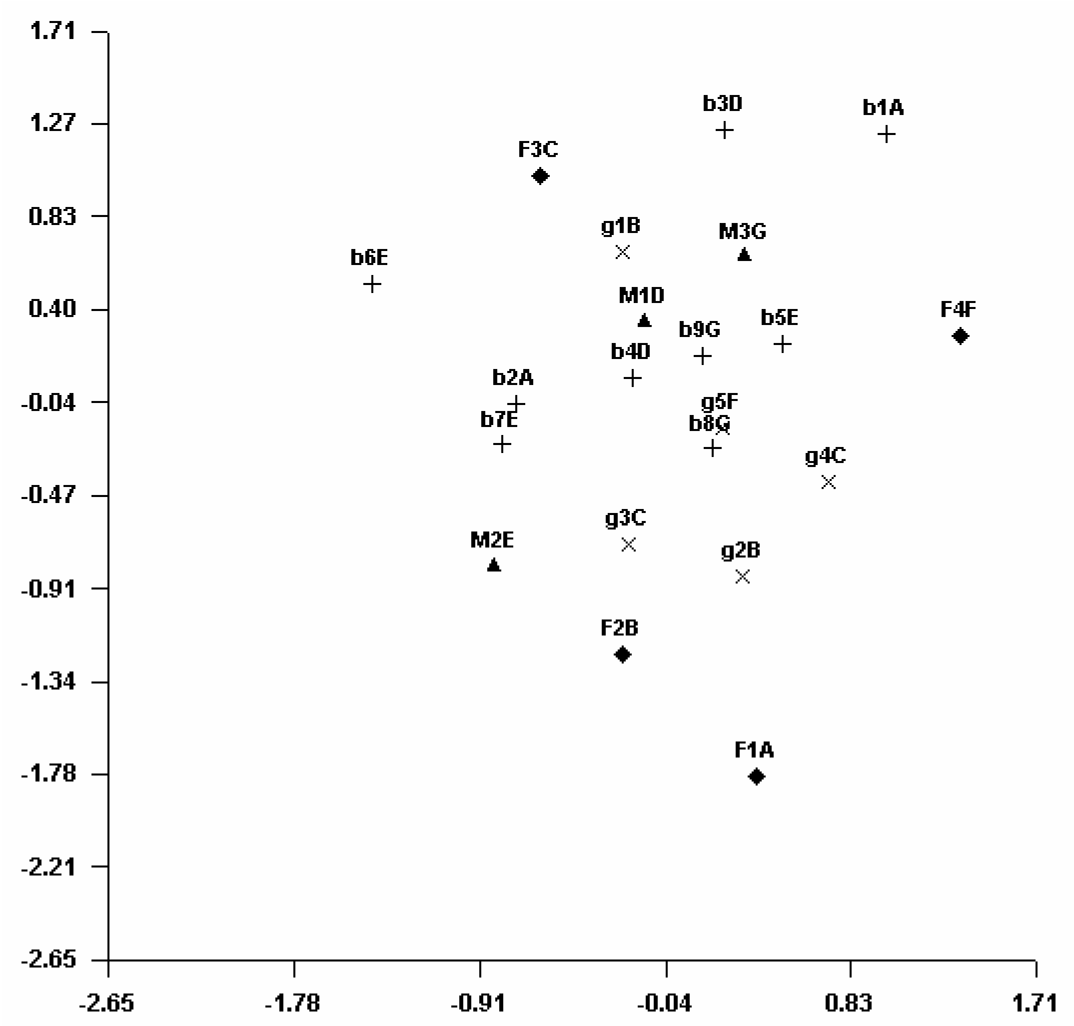
'Plans and theories' forum
Group forums


100%
80%
60%
40%
20%
0%
Prel. phase
1
2
3
4
5
6
7 & 8
Course week
Community building
Content of inquiry
Process organization
Course evaluation
Other issues


1.71
1.27
0.83
0.40
-0.04
-0.47
-0.91
-1.34
-1.78
-2.21
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-2.65
-1.78
-0.91
-0.04
0.83
1.71
b3D
b1A
F3C
g1B
M3G
b6E
M1D
b9G
b5E
F4F
b4D
b2A
b7E
g5F
b8G
g4C
g3C
M2E
g2B
F2B
F1A

Learning in asynchronous discussion groups: A multilevel approach to study the influence of student, group and task characteristics

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Abstract
The research reported in this article studies the impact of learning in asynchronous discussion groups on students' final exam scores and levels of knowledge construction. Multilevel analyses were applied to uncover the specific influence of student, group, and task variables. The results indicate that the impact of student characteristics on both dependent variables is of higher significance than characteristics of the discussion group students are allocated to. With regard to levels of knowledge construction, task characteristics also appear to be of importance.

With regard to final exam scores the analyses reveal a significant impact from student learning style, attitude towards task-based learning, the number of student contributions, and the level of knowledge construction in these contributions. No significant group characteristics were observed.

As to levels of knowledge construction, the analyses revealed that the amount of contributions and the attitude towards the online learning environment are significant predictors. The intensity of the interaction in a group had a significant impact. As to task characteristics, significant differences were found between consecutive themes. These disappeared when taking into account task complexity.

Keywords: Computer-mediated communication; cooperative/collaborative learning; interactive learning environments; post-secondary education

1. Introduction

There is a growing body of empirical research that grounds theoretical assumptions about the impact of Computer-Supported Collaborative Learning (CSCL) on motivation, social processes, and cognition. Studies confirm that student involvement is more intense and equally distributed among group members in CSCL environments as compared to face-to-face sessions (Cooney, 1998; Kang, 1998). CSCL promotes metacognitive processes (Alavi, 1994; Ryser *et al.*, 1995), reflective interaction (Baker and Lund, 1997), and problem solving (Jonassen and Kwon, 2001). Students are more interested and more intrinsically motivated (Reiser, 2001; Wolters, 1998). Finally, it appears that high levels of cognitive knowledge construction are reached (Schellens and Valcke, 2002) and critical thinking and inquiry is promoted (Duffy *et al.*, 1998).

The present study focuses on the impact on knowledge construction and academic performance. It builds on preceding research that already identified a positive and significant impact of CSCL on knowledge construction (Schellens and Valcke, 2002, 2005). But the actual research especially focuses on the identification of key variables that help to account for the positive impact of CSCL. Research about collaborative learning has moved beyond the question of whether collaborative learning is effective and focuses now on the conditions that define the efficacy and efficiency of CSCL. Moreover, since CSCL does not systematically produce positive learning outcomes (Dillenbourg, 2002; Lockhorst *et al.*, 2002), the reorientation is helpful to shed light on possible explanations for the lack of a positive impact in some CSCL studies. Researchers report large variations in the quality of interaction and learning outcomes (Häkkinen *et al.*, 2001; Lethinen *et al.*, 1999). Some of these differences are due to differences in length of studies, technology used, or differences in research methodology, but might also be due to the quality of the group processes (Shaw, 1981; Strijbos *et al.*, 2004). Therefore, the present study will especially focus on the impact of student, group, and task characteristics on dependent variables.

After a short description of the research context and a description of the potential impact of student, group, and task variables, the theoretical framework of the study is presented. The major part of the article centres on the in-depth description of a multilevel analysis of the research data. The conclusions focus on the implications of the research results and directions for future research.

2. Context of the present study

The study is set up in the context of a 7-credit, first year university course 'Instructional Sciences' that is part of the academic bachelors' curriculum 'Pedagogical Sciences' at Ghent University. This freshman course introduces students to a large variety of complex theories and conceptual frameworks related to learning and instruction. The innovative redesign of this course has been studied and monitored since 1999-2000 and focuses on the implementation of social-constructivist principles, such as active learning, self-reflection, authentic learning, and collaborative learning (Schellens and Valcke, 2000).

The asynchronous discussion groups, studied in the present study, were a formal part of the course. Students participated in the discussion groups during a complete semester (October--January). Every three weeks a new discussion theme was introduced. The aim of introducing discussion groups was to form communities of practice, where students come together to help out each other, solve problems, and share and create knowledge collaboratively (De Laat, 2002). The objectives of participation in the discussion were communicated to the students: active processing of the theoretical base that was introduced during weekly face-to-face working sessions and application of this knowledge while solving authentic cases.

3. Theoretical exploration of student, group, and task variables

Learning in CSCL settings can be considered as a specific type of collaborative learning. The theoretical and empirical studies in this area present convincing empirical evidence to ground collaborative learning in a large variety of instructional settings. Taking the review studies and meta-analyses of Johnson and Johnson (1994) and Slavin (1995) as a starting point, a concrete list of design guidelines for collaborative learning can be put forward. Analysis of some of these guidelines helps to determine and to position student, group, and task variables, which will be taken into account in the present study.

Two basic guidelines stress the need for 'positive interdependence' and 'individual accountability'. Positive interdependence implies that team members need each other to succeed (Johnson *et al.*, 1998). Individual accountability refers to the measurement of whether or not each group member has achieved the group's goal. The literature also presents concrete suggestions to guarantee the implementation of the guidelines. In relation to positive interdependence, they refer to specific strategies, such as presenting challenging tasks, which stimulate learner's intrinsic motivation and collaborative skills (Cohen, 1994), assigning the group a clear, measurable task, and finally blending positive goal interdependence with other types of positive interdependence (Johnson *et al.*, 1998). In relation to individual accountability, authors advise to keep the size of the groups small, to present individual tests to each student or control for understanding, and to observe each group and group member and keep track of students' contribution to the group's work, assessing both the quality and quantity of individual contributions (Johnson *et al.*, 1998).

Analysis of the guidelines results in the following implications for CSCL that help to account for student, group, and task variables. With regard to task characteristics, the guidelines suggest to put forward a very clear and measurable task. However, not all authors agree as to this issue. Cohen (1994) for example states that a strong structuring of the task might hamper the collaborative process. Recent research in CSCL settings suggests that a clear task structure is needed to foster cognitive processing and academic performance (Dillenbourg, 2002; Roschelle and Pea, 1999; Weinberger *et al.*, 2003). Research also points at the need to explicitly state directions, guidelines, and types of expected cognitive processing that lead to a qualitative discussion and intended outcomes (Cifuentes *et al.* 1997; Harasim *et al.* 1998; Palloff and Pratt, 1999; Schellens and Valcke, 2005). Hakkarainen *et al.* (2002) also indicate the need to prompt students to articulate their conceptual understanding to promote learning and knowledge building. More research is, however, needed to get a better understanding of the impact of task features (Thatcher and De La Cour, 2003). Therefore, task complexity will be considered as a key research variable in the present study.

In relation to group characteristics, prior research has stressed the importance of fostering intensive group interaction (Dillenbourg *et al.*, 1995; Schellens and Valcke, 2005). These authors also point at the relationship between levels of interaction and group size. More specifically, they argue that a smaller group size, with 8 to 10 students, results in the highest level of group interaction. This is, however, not consistent with the opinion of others researchers. Most are in favour of groups that consist of four to five students, because larger groups do not provide an opportunity for all members to participate and enhance their skills (Cooper *et al.* 1990; Johnson *et al.*, 1998; Nurrenbern, 1995; Slavin, 1995). The literature also centres on group composition as an important group variable. Research results, however, are rather contradictory. Some studies emphasize that groups should be heterogeneous (Cooper *et al.*, 1990; Johnson *et al.*, 1998; Nurrenbern, 1995; Slavin, 1995). Other studies contradict this position (Felder *et al.*, 1995; Rosser, 1997; Sandler *et al.*, 1996). In the context of the present study, group size will be kept constant (8-10) and group composition will be randomized, to obtain heterogeneous groups. Intensity of the group interaction will be controlled and used as a research variable.

Regarding the characteristics of individual students, the cooperative learning literature hardly gives indications whether specific characteristics advance or hinder cooperative learning; but authors do report about interaction effects (Johnson and Johnson, 1994; Slavin, 1995). The same applies to research in the field of CSCL. Variables such as gender, age, and appreciation are mostly considered as background variables. Hakkarainen and Palonen (2003), for example, report about the impact of gender on students' interest in CSCL, which might influence learning outcomes. Kreijns *et al.* (2003) have identified studen' learning styles as a factor that influences the effectiveness of collaborative learning. Schellens and Valcke (2000) found that consistency between the requirements of the online learning environment and learning styles is important. In the same study, they also pointed at student satisfaction, which interacts with the impact on cognitive outcomes. This is in line with the findings of Desmedt (2004) who states that learning styles play their role as individual difference variables within the full complexity of the learning process.

In the context of the present study the following variables will be considered in the theoretical base: learning styles and attitude towards studying in the CSCL environment.

In the following section, the task, group, and individual variables discussed will be integrated into a broader theoretical framework to ground our hypotheses about the impact of CSCL on knowledge construction and academic performance. In the research design and analysis of the results, these three clusters of variables will also form the basis of a multilevel analysis to study their specific and interaction effect on the dependent variables.

4. Theoretical framework of the present study

Figure 1 gives a graphical representation of the theoretical base for the present study. It integrates social constructivist principles and concepts derived from the information processing approach to learning (for comparable approaches see Baker, 1996; Doise and Mugny, 1984; Erkens, 1997; Kreijns and Bitter-Rijkema, 2002; Petraglia, 1997; Savery and Duffy, 1996).

Insert Figure 1 about here

The figure depicts three key substructures: (1) the individual learning process of a student, (2) the task put forward in the CSCL environment, and (3) the group dimension in the CSCL setting. The learning process of an *individual student* (student a) is presented at the centre. 'Learning' is considered as information processing activity, building on the assumption that learners engage actively in cognitive processing to construct mental models (or schemas), based on individual experiences. In this way, new information is integrated into existing mental models. The *active processing assumption* invokes three types of processes in and between working and long-term memory: selecting, organizing, and integrating information (Mayer, 2001). The mental models are stored in and retrieved from long-term memory. Because of the importance of individual experiences and the pre-existing cognitive structures, characteristics of the individual learner, such as attitude towards the learning environment and the group discussion, gender, and learning styles are considered of importance. Moreover, it is hypothesized that the more students express their line of thought, the more the construction of mental models is facilitated. Therefore, the amount of individual contributions is regarded as relevant.

A second substructure points at the impact of *the task* put forward in the learning environment and discussed in the CSCL setting. The assignments trigger the cognitive processes of the individual students. The content and complexity of the task are considered to influence the nature of the cognitive activities, resulting in output that reflects certain levels of knowledge processing.

Finally, a third substructure refers to the importance of *the group* in the CSCL setting. An important characteristic in this respect is the intensity of interaction. The task is put forward in a collaboration environment. This invokes *collaborative learning* that builds on the necessity of the learner to organize output that is relevant input for the other learners (student a to n). The exchange at input and output level is assumed to reflect a richer base for the cognitive processing of each individual group member. This assumption is essential in the cognitive flexibility theory of Spiro *et al.* (1988). The output is also a central element in the theoretical base of the present study. The asynchronous nature of the discussion environment forces the learner to communicate the output in an explicit way. All the written communication in the CSCL environment is therefore considered as relevant. In this respect, Gunawardena *et al.* (1997) use the concept of *entire Gestalt*. The written student output mirrors their concrete processing activities. Individual processing is slowed down by the complex nature of the tasks since learners have to cope with selection, organization, and integration processes. As a consequence, learners experience the limited capacity of their working memory (Mayer, 2001), also referred to as cognitive load (Sweller, 1988, 1994). However, learners in a collaborative setting can profit from the processing effort of other group members. The output of each individual student is organized since it is derived from his/her own mental models. Therefore it is assumed that this output is more easily accessible for other learners in the collaborative setting. Since the output of other learners is organized, students are expected to experience lower levels of cognitive load when using this output as input for their own individual cognitive processing. This subsequent output is expected to be of a better quality, thus reflecting a higher level of knowledge construction. In the present study, we build on the work of Gunawardena and her colleagues (1997) to identify students' levels of knowledge construction.

The content analysis scheme of Gunawardena and colleagues (1997) has been developed following a grounded theory approach. It proposes a typology to evaluate knowledge construction through social negotiation. The authors developed an interaction analysis model that discriminates between five phases in the negotiation process during a social constructivist learning process. Every phase corresponds to a typical level of knowledge construction. In the long run, every learner is expected to progress to the highest phases in this negotiation process:

- *Phase 1. Sharing/comparing information:* In this phase, typical cognitive processes reflect observation, corroboration, clarification and definition.
- *Phase 2. Dissonance/inconsistency:* In phase 2, cognitive processes focus on identifying and stating, asking and clarifying, restating, and supporting information.
- *Phase 3. Negotiating what is to be agreed (and where conflicts exist)/co-construction:* This type of message is about proposing new co-constructions that encompass the negotiated resolution of the differences.
- *Phase 4. Testing tentative constructions:* The newly constructed structures are tested, and matched to personal understanding and other resources (such as the literature).
- *Phase 5. Statement/application of newly-constructed knowledge:* This is related to final revisions and sharing the new ideas that have been constructed by the group.

5. Research design

5.1. Participants

All students enrolled for the 7-credit freshman course 'Instructional Sciences' participated in the present study ($N = 230$). Students were randomly assigned to one of the 23 discussion groups. Approximately 10% of the freshmen were male students. The largest part of the students (88%) just finished secondary education; 12% already possessed a diploma of higher education.

5.2. Procedure

After a trial discussion session of three weeks, students participated in four consecutive discussion themes. The entire experimental treatment lasted four months. Students were flexible as to time and place to work on the discussion assignments, within the three-week time frame.

During the first face-to-face session of the semester, a demonstration was given of the CSCL environment. Extra information was made available in an online learning environment. A number of strict rules, which defined the nature of expected student participation, were stated: (a) Participation in the discussion groups was a formal part of the curriculum. Participation was scored and represented 25% of the final score. (b) Successful participation implied that each student posted at least one primary reaction to solve the case, making active use of the course reader. Secondly, each student was expected to reply at least once to the work of another student, with arguments based on the course reader. (c) The moderator followed the ongoing discussions and restricted interventions to giving structural feedback (scaffolding).

After three weeks, students no longer had access to a particular theme since a new discussion theme was presented.

At the start and at the end of the course, a number of instruments were administered and a questionnaire had to be filled out by the students. The questionnaire helped to gather data about the student characteristics: age, gender, and educational level. Next, a special section was added to measure the student characteristics ‘attitude towards the task-based learning environment’ and ‘attitude towards the group discussions’.

Furthermore, the Approaches and Study Skills Inventory for students (ASSIST) was presented to the students to gather information about the student characteristic ‘learning styles’. Reported reliability for the ASSIST is high, with Cronbach’s α between .80 and .87 (Entwistle *et al.*, 2000).

The information about the group characteristic ‘intensity of interaction’ was derived from the analysis of the contributions to the discussion groups. The task characteristic ‘task complexity’ will be explained when giving information about the discussion themes.

5.3. Hypotheses

Central in the present research is the question to what extent the impact of CSCL on academic performance and knowledge construction is influenced by student, group, and task variables. The consecutive hypotheses research step-by-step sub-questions in relation to this general research question.

1. Hypotheses related to the impact of CSCL on academic performance as measured by the final examination.

Impact of student characteristics:

- More intensive and active participation in the discussion groups will have a significantly positive impact on the final exam scores.
- Students who achieved high levels of knowledge construction during the discussion groups will obtain significantly higher final exam scores.
- Student with a deep or strategic learning style will obtain significantly higher final exam scores.

Impact of group characteristics:

- Students who participate in a discussion group with intensive discussion activity will obtain significantly higher final exam scores.

2. Hypotheses about the impact of CSCL on academic performance as reflected in the levels of knowledge construction.

Impact of student characteristics:

- More intensive and active participation in the discussion groups is positively related to students’ level of knowledge construction.
- Students with a positive attitude towards task-based learning at the beginning of the academic year will reach significantly higher levels of knowledge construction.
- Student with a deep or strategic learning style will obtain significantly higher levels of knowledge construction.

Impact of group characteristics:

- Being part of a group with intensive discussion activity will lead to significantly higher individual levels of knowledge construction.

Impact of task characteristics:

- Students will reach higher levels of knowledge construction as the discussion progresses.
- The complexity of the task has a significant impact on the level of knowledge construction.

5.4. Discussion themes

In weekly face-to-face lectures, students were introduced to a large variety of complex learning theories and conceptual frameworks related to learning and instruction (behaviourism, cognitivism, constructivism,…).

Parallel to the lectures, active processing of the theoretical base and application of the knowledge introduced in the face-to-face sessions was stimulated by working in the discussion groups.

In line with constructivist principles, the discussion themes were based on real-life authentic situations. Simplified examples of assignments were developing an online learning environment for the course X for higher education students, starting from a behaviouristic approach to learning and instruction; visiting a virtual museum, discussing whether it is a constructivist learning environment, develop a checklist, and suggesting adjustments to improve the museum in view of a more constructivist approach to learning and instruction; discussing the advantages and disadvantages of the different evaluation approaches in view of specific criteria, …

These tasks were supported with useful links to Websites and additional questions were presented to structure the task completion.

The task complexity was controlled for since it was a key variable in the research design. The degree of complexity of the tasks showed an upward trend, with the third assignment as the most complicated. In the initial tasks students only had to deal with a limited number of questions. Moreover, the assignments were supported with all the necessary information (clustered on the same Web page), documented with the conceptual base and a solution procedure was suggested in the learning environment. The tasks presented during the third and fourth discussion theme were more comprehensive (information on different Web pages) and complex, the conceptual base was not completely given and/or clear, additional information had to be looked up using different sources, and the solution procedure was not completely prescribed. A lot of information was given in English as a foreign language and more supplementary questions had to be answered.

The discussion groups were implemented with the tool Web Crossing conferencing server (http://webcrossing.com/). This tool allows students to manage their own contributions and the threaded discussion structure. Figure 2 and 3 illustrates the threaded discussion and shows an excerpt of the discussion.

Insert Figure 2 and 3 about here

5.5. Analysis of the transcripts of the discussion groups

The transcripts of the output of 230 students for 4 different themes represent a massive amount of research data. For analysis purposes, eight groups were randomly selected from the 23 discussion groups. All communication submitted in relation to the four discussion themes was used for analysis purposes.

5.6. The unit of analysis

In line with the suggestion of Rourke *et al.* (2001), the complete message was chosen as the unit of analysis for the coding. In a limited number of cases, messages were split into subparts. Reliability of this approach was controlled for (percent agreement > .80). A total of 1428 units of analysis were distinguished.

5.7. Coding of the messages in the transcripts

Each unit of analysis was coded by three independent research assistants. Atlas-Ti® was used as the coding tool. The research assistants were trained extensively by using sample data.

Group discussion helped to get acquainted with the particularities of the schemes and to reach mutual agreement about the coding category to be selected. Assessment of inter-rater reliability resulted in quite high percent agreement measures. The initial value was .81; after negotiations, percent agreement was .87. To check whether it was not always the same research assistant changing his/her coding, percent agreement was also calculated for each individual research assistant. All values were larger than .70.

5.8. Statistical analysis

The research design was set up in an authentic setting with an entire first year student population randomly assigned to different discussion groups. A particular characteristic of the study is that no control group is used in the design. From an ethical perspective it was not acceptable to exclude a group of students from the formal learning process. Moreover, considering the nature of the research question a traditional control group is not needed.

Because in the present study the students ($N = 230$) are divided in a number of groups ($N = 23$), the problem under investigation has a clear hierarchical structure. The individual observations are not completely independent because of what individuals share in the group setting (Hox, 1994, Stevens, 1996). The critical position of statistical analysis techniques has only recently been raised in CSCL research. Traditional analysis techniques that consider individual student measures as the base for analysis are questionable because assumptions about independence of residual error terms are violated. Moreover, cross-level interactions between explanatory variables defined at different levels of the hierarchy can influence the individual outcome variable (Hox and Kreft, 1994). Because of this joint modelling of individual and group variables, we took a multilevel modelling perspective on analyzing the data, as these models are specifically geared to the statistical analysis of data with a clustered structure. Applying multilevel analysis results in more efficient estimates of regression coefficients, and more correct standard errors, confidence intervals, and significance tests, all of which will generally be more conservative than the ones obtained when ignoring the presence of clustered data (Goldstein, 1995). To analyze the data, MlwiN for multilevel analysis was used (Rasbash *et al.*,1999).

6. Results

6.1. Hypothesis testing procedures

To test the hypotheses about the impact of CSCL on the final exam score of the students, a two-stage procedure was followed. The first stage consisted of the estimation of a two-level null model, with students (level one) hierarchically nested within discussion groups (level two), only including the intercept and initially no explanatory variables. This model served as a baseline with which subsequent more complex models are compared. The model also partitions the total variance of the dependent variable (i.e. exam scores) into two components: between-groups and between-students within-groups variance.

The second stage in the analysis consisted of entering the variables at group or student levels, which were hypothesized to affect the dependent variable. Continuous independent variables were centred around the grand mean to facilitate interpretation of the intercept. The student characteristics gender, learning style, students' attitude towards task-based learning, level of knowledge construction during the discussions, and the amount of messages posted were added to the model. With respect to group characteristics, the intensity of interaction (the amount of original contributions and reactions to the discussion per group) was included in the model. Initially, all variables were included in the model as fixed effects, assuming that their impact did not vary from student to student or from group to group. Afterwards, this assumption of a fixed linear trend was verified for each explanatory variable by allowing the parameter coefficients to vary randomly across groups and across students within groups.

Table 1 presents the gradual construction of the model, using the iterative generalized least squares (IGLS) estimation procedure. In this table the model is presented with students' level of knowledge construction as an explanatory variable. To guarantee a full understanding of the analysis procedure, all intermediate steps in the construction of the most appropriate model will be explained.

To test the hypotheses regarding the impact of CSCL on the levels of knowledge construction, a similar two-step procedure was followed. The different analyses focused on (1) the students' mean level of knowledge construction for each discussion theme and (2) on the highest level of knowledge construction attained per theme. Since multilevel models are very useful for analyzing repeated measures (Snijders and Bosker, 1999), a special kind of hierarchical modelling was defined with regard to the levels of knowledge construction data as collected during the four consecutive discussion themes: measurement occasion (discussion theme 1 to 4) nested within students. In this way a three-level structure arose: measurement occasions (level one) are clustered within students (level two) that are nested within discussion groups (level three). Table 3 and Table 5 respectively present the results of the final best-fitting models for students' mean level and for students' highest level of knowledge construction, using the iterative generalized least squares (IGLS) estimation procedure.

6.2. Hypotheses with regard to the final exam scores

As stated earlier, to test this first cluster of hypotheses about the impact on student final exam scores, a full description is given of the stepwise procedure to construct the best fitting models.

The first step in our analysis was to examine the results of a fully unconditional two-level null model (Model 0). The intercept of 9.53 in this model represents the overall mean of the final exam scores of all students in all discussion groups. This initial analysis entails the estimation of the total variance of the dependent variable (9.11), the sum of the level-one and level-two variance components. The total variance is further decomposed into between-groups and between-students variance. The random part of the null model reveals that only the variance at student levels is significantly different from zero ($\chi^2 = 120.50$, $df = 1$, $p = .000$). Only 6% of the overall variability in the final exam scores can be attributed to group-level factors or between-group differences, and 94% of the variance is due to differences between individual students within the discussion groups. In other words, the estimates suggest that the differences between students in exam scores within the groups far outweigh the differences between groups. However, to be consistent with the following analyses and to be able to compare the results, we still decided in favour of multilevel analyses.

To test the hypotheses, explanatory variables were included in the analysis. Since parsimonious models are preferred, only significant predictors ameliorating the model were retained. In Table 1 models that were not retained for further analysis are represented in grey. First, the '*amount of messages*' was introduced into the model as a student-level explanatory factor. As Model 1 in Table 1 reveals, this variable appears to be a positive and significant predictor ($\chi^2 = 13.23$, $df = 1$, $p = .000$) of final exam scores. As it is feasible that level 1 and level 2 variances in exam scores differ according to the number of messages posted, we next allowed the parameter estimate of this predictor to vary randomly across all discussion groups and students. No significant complex variances were found, which indicates that the variances in the final test scores are fixed and independent of the amount of individually posted messages.

Next, '*gender*' was added to the fixed part of the model (Model 2a). As can be derived from Table 1, the inclusion of this variable results in a significant improvement of Model 1 ($\chi^2 = 115.84$, $df = 1$, $p = .000$). Moreover, Table 1 shows that girls significantly outperform boys on the final exam scores ($\chi^2 = 4.51$, $df = 1$, $p = .034$).

In Model 2b the interaction effect between 'gender' and 'the total amount of messages a student posted' was tested. This analysis pointed out that there is no significant interaction and that there is no improvement as compared to Model 2a. Neither the interaction effect ($\chi^2 = 0.39$, $df = 1$, $p = .533$) nor the difference in the deviance of model 2a and 2b ($\chi^2 = 0.37$, $df = 1$, $p = .542$) is statistically significant. Taking this result into account, the next model was based on Model 2a instead of Model 2b.

The next student characteristic was added to the model: *'student attitude towards task-based learning'* (Model 3). There appears to be a significant effect of this variable on final exam scores ($\chi^2 = 26.43$, $df = 1$, $p = .000$), implying that the more students appreciate task-based learning, the higher the scores they obtain on the final test. This model is a significant improvement of model 2a ($\chi^2 = 40.91$, $df = 1$, $p = .000$).

The inclusion of *'learning styles'* was based on the administration of the short version of the ASSIST (Entwistle *et al.*, 2000). On the basis of this instrument, we could distinguish between students with a '*deep approach*', a '*strategic approach,*' and a '*surface approach'*. Two dummies were created with the deep and strategic approach contrasted against the reference group with a surface study approach (Model 4). Adding these dummies, the model appears to be a significant improvement over Model 3 ($\chi^2 = 180.65$, $df = 2$, $p = .000$). Moreover, the analysis reveals significant effects for students with a deep ($\chi^2 = 14.98$, $df = 1$, $p = .000$) and strategic approach ($\chi^2 = 7.03$, $df = 1$, $p = .008$). The results imply that students with a deep or a strategic approach accomplish significantly higher final exam scores than students with a surface approach. However, as can be derived from Table 1, the initial significant effect of the variable *'gender'* disappears after adding the variable *'learning styles'*.

To study whether the level of knowledge construction obtained by individual students played a decisive role, the next analysis focused on adding '*the mean level of knowledge construction*' students reached for their postings over the four discussion themes (Model 5a). For the fixed part, we observe no significant effects ($\chi^2 = 0.11$, $df = 1$, $p = .742$), which seem to imply that the mean level of knowledge construction does not really matter. What appears to be more important, however, is the number of messages students contribute to the discussion. However, by allowing the coefficient of the mean level of knowledge construction to vary randomly across groups and across students within groups (Model 5b), we notice a significant complex variance at student level. More specifically, the quadratic variance function indicates that the variance between students in their final test scores decreases when a student's mean level of knowledge construction increases. However, this broader model is not significantly better than the previous model ($\chi^2 = 0.11$, $df = 1$, $p = .744$).

Second, if we include '*the highest level of knowledge construction a student reached for a posting'* in the model (Model 5c), no significant effect is observed ($\chi^2 = 0.43$, $df = 1$, $p = .512$). Allowing the main effect of this variable to vary at random at student and group level (Model 5d) did lead to a significant fixed effect, implying that students with higher levels of knowledge construction also attain significantly higher final test scores. Moreover, significant complex variance at student level is obtained, revealing that the variance between students in their final test scores decreases when the students' highest level of knowledge construction ever reached increases. In other words, the higher the level of knowledge construction ever reached by an individual student, the more predictable their score on the final exam. This new model is a better fit to the data than Model 5c ($\chi^2 = 12.34$, $df = 2$, $p = .002$).

By adding student learning style, as in Model 4, we notice again an improvement of the model. The difference in deviance of both models is statistically significant ($\chi^2 = 183.79$, $df = 2$, $p = .000$). As can be seen in this model (Model 5e) the impact of gender is no longer significant. Therefore this explanatory variable was excluded from the model, which leads us to the final and most appropriate model (Model 6). Model 6 reflects that the posting of a high number of messages has a significant positive impact on final exam scores. Moreover, the highest level of knowledge construction in the messages contributed to the discussion has an additional impact; as well as the learning style of the student and his or her attitude towards task-based learning. Students with a ‘deep’ or a ‘strategic’ approach and a high appreciation for task-based learning will also attain higher scores on the final exam. No significant group-level explanatory variables were found, implying that the characteristics of the group to which students are assigned do not have a significant impact on the final exam scores. Moreover, also the group level random part indicates that no significant part of the variance final exam scores is explained by group-level factors.

Insert Table 1 about here.

To facilitate the interpretation of the estimates and get a better understanding of the statistical power of the obtained effects, effect sizes were calculated for both final models and included in Table 2.

Insert Table 2 about here.

Conclusion: As to the hypotheses with regard to the impact on final exam scores, we can conclude that student characteristics have a much more important impact on final exam scores than group characteristics. Learning style has the most significant impact on exam scores. Furthermore the attitude towards task-based learning, the number of messages they contributed to the discussion and the level of knowledge construction in these contributions significantly affect final exam scores. The intensity of group discussions, however, has no significant impact on individual exam scores. This implies that we can reject the hypothesis on the level of group characteristics: students who participate in a discussion group with intensive discussion activity do not obtain significantly higher or lower final exam scores than students in less intensive discussions. The hypotheses about the impact of student characteristics, however, are all confirmed by the research results. Individual active participation in the discussion groups has a significantly positive impact on final exam scores: the more messages students contribute to the different discussion themes, the higher their final exam scores. In addition, the level of knowledge construction matters as well: students achieving higher levels of knowledge construction attain significantly higher final scores. Finally, the hypothesis with regard to student learning styles is confirmed also, implying that students with a strategic or deep learning style obtain significantly higher final exam scores than students with a surface learning style.

6.3. Hypotheses with regard to the level of knowledge construction

To test the hypotheses regarding to the impact on the level of knowledge construction similar two-step procedures were followed. Two tests of the hypotheses were performed, building on two different operationalisations of the dependent variables: (1) the students’ *mean level* of knowledge construction per discussion theme and (2) the *highest level* of knowledge construction per theme.

6.3.1. Mean level of knowledge construction per discussion theme. As can be inferred from Model 0 in Table 3, the overall variability in the mean level of knowledge construction per discussion theme can be attributed mostly (79.41%) to theme-level factors (differences between the four discussion themes), for 18.49% to group-level factors (differences between the groups), and only for 2.10% to differences between students within the groups. This is an important finding implying that differences between groups and between students are much smaller than differences in students’ levels of knowledge construction between different assignments. As a consequence, it is necessary to consider characteristics of the theme assignments in our analysis.

To understand the changes in the level of knowledge construction from discussion theme 1 to theme 4, the variable '*measurement occasions*' was added to the fixed part of the model (Model 1). No significant changes in levels of knowledge construction are observed for the second theme ($\chi^2 = 0.003$, $df = 1$, $p = .956$). However, for the third ($\chi^2 = 12.34$, $df = 1$, $p = .000$) and fourth theme ($\chi^2 = 4.70$, $df = 1$, $p = .030$), a significant decrease in students' mean levels of knowledge construction is observed. In the best fitting model (Model 2), we see that the number of messages ($\chi^2 = 16.19$, $df = 1$, $p = .000$) and students' attitude towards the discussion groups have a significant positive effect on students' mean level of knowledge construction per discussion theme. Students who 'rather like' working in discussion groups ($\chi^2 = 4.33$, $df = 1$, $p = .037$) and students who 'really like' it ($\chi^2 = 3.94$, $df = 1$, $p = .047$) attain higher mean levels of knowledge construction. Learning styles do not seem to be a significant predictor. Only the group characteristic 'group interaction intensity' had a significant impact on the dependent variable. Compared to groups with low discussion activity, there was a significant effect for groups with high discussion intensity ($\chi^2 = 4.17$, $df = 1$, $p = .041$) but not for groups with average discussion activity ($\chi^2 = 0.61$, $df = 1$, $p = .433$). Figure 4 illustrates the differences between groups characterized by low, average, and high interaction patterns.

Insert Figure 4 about here

We already referred to the importance of the theme assignment characteristics when we observed significant differences between students' mean level of knowledge construction per theme. We test whether the differences in the level of knowledge construction between discussion themes will still be observed after adding a variable that estimates the complexity of the theme assignment. After including the variable '*task complexity*' in the model (Model 2), we no longer observe significant differences between the themes. Based on this finding we can state that the increasing degree of complexity of the theme assignments was at the base of the surprising results about the significant decrease in levels of knowledge construction in the last two discussion themes. It makes us aware of the fact that characteristics of the assignment are of essential importance to foster knowledge construction. This will have crucial implications for designing CSCL environments.

In summary, we can conclude that student, group, and task characteristics influence the mean level of knowledge construction. At the student level, the individual number of postings, a positive attitude towards task-based learning and a high appreciation for group discussions results in higher mean levels of knowledge construction. At the group level, groups with a high level of activity have a positive impact. Finally, the complexity of the theme assignments affects the mean level of knowledge construction. The significant decrease in level of knowledge construction reported earlier disappears when correcting for task complexity.

6.3.2. Highest level of knowledge construction per theme. With regard to students' highest level of knowledge construction per theme as the dependent variable, Table 5 reveals that the highest proportion of the variance is accounted for by theme level factors (77% and 81.2%). When including the variable '*theme*' in the model, no overall significant changes in levels of knowledge construction are observed. Further, only one additional significant explanatory variable could be detected: the total amount of messages posted by individual students (Model 1: $\chi^2 = 67.04$, $df = 1$, $p = .000$). Figure 5 illustrates this increase in levels of knowledge construction as it is related to the amount of individual contributions. In line with the observation that the third discussion theme is the most complex one, Figure 5 shows that students contributed the lowest number of messages to this discussion theme and consequently attained lower levels of knowledge construction.

Insert Figure 5 about here

From this alternative analysis about the impact on the dependent variable *'level of knowledge construction'*, we conclude that the only significant variable is the total amount of messages posted by individual student. All other student, group and task characteristics do not significantly influence the highest level of knowledge construction.

7. Discussion and conclusion

7.1. Hypotheses with regard to the final exam scores

With regard to the hypotheses on students' final exam scores, the present study focused on the impact of both student and group characteristics. First, we can conclude that the impact of student-level variables on student final exam scores is apparently of more significance than characteristics of the discussion group. The following factors significantly influence the final exam scores: (1) the attitude towards task-based learning, (2) the number of messages submitted to a discussion, (3) the level of knowledge construction and (4) the learning style of students. Consequently, we can conclude that all hypotheses in relation to the impact of student characteristics can be accepted. Active participation in the discussion groups has a significantly positive impact on their exam scores. Apart from the number of contributions, the level of knowledge construction reflected in the contributions also matters: students reflecting higher levels of knowledge construction attain significantly higher exam scores. Learning style has the most important impact on final exam scores. It appears that students with a strategic or deep learning style perform significantly better on the final exam than students with a surface approach.

As to the influence of group level characteristics, the results do not reveal a significant impact. The hypothesis about the potential impact of group characteristics has to be rejected. Students participating in a highly active discussion group do not obtain significantly higher or lower final exam scores. This result entails that what especially matters is the individual contributions of students and not the fact whether they are part of a group with high or low interaction intensity.

These findings are important because they suggest that stimulating students to be active and to contribute on a frequent basis leads to better performance. It also appears that student attitudes are to be considered, e.g. their attitude towards the kind of (online) learning environment is of importance. The question arises, how to influence these variables? As Westrom (2001) states, most students can be good learners, but only if they want to learn. Comparable to other researchers (Jones, 1998; Quinn, 1997), he stresses that learning should be an enjoyable activity. Instead of using a rewards system, he suggests fostering *engagement* in the learning activities. Westrom (2001) suggests combining peer pressure and teacher supervision to keep students on task. But in an online environment, the pressure of fellow students and teachers is not so prominent. Student autonomy is high and self-discipline has to be developed to keep students focused. There are a number of recognized strategies consistent with constructivist approaches to learning and instruction to foster engagement in an online learning environment: achievable goals, authentic learning, and tasks set at the appropriate complexity level.

7.2. Hypotheses with regard to the level of knowledge construction

With regard to the hypotheses focusing on the levels of knowledge construction, the study analyzed the impact of student, group, and task characteristics. The results indicate that a large part of the overall variability in levels of knowledge construction can be attributed to differences between the theme assignments.

As to the impact of student characteristics, the amount of individual contributions is a significant predictor of both the mean and highest level of knowledge construction. The mean level of knowledge construction is also significantly influenced by the attitude towards task-based learning and the attitude towards the group discussions. Accordingly, it can be concluded that the first two hypotheses about the impact of student characteristics are confirmed. More intensive and active individual participation in the discussion groups is positively related to students' achieved level of knowledge construction, as well as adopting a positive attitude towards the learning environment and towards participating in group discussions. The third hypothesis, however, has to be rejected. No significant differences in levels of knowledge construction were found for students with different learning styles. Students with a deep or strategic learning style did not obtain a significantly higher level of knowledge construction compared to students with a surface approach.

Regarding the impact of group characteristics, students in groups with a lively discussion perform at a qualitatively higher level, which is in line with earlier research findings (Schellens and Valcke, 2005). Again this result points to the importance of stimulating students to discuss.

As to the impact of task characteristics, significant differences between the consecutive themes were found. However, these were not in line with the expected results. It was hypothesized that students would reach higher levels of knowledge construction as they deal with the consecutive theme assignments. The results showed a significant decrease in levels of knowledge construction, especially for the third theme. Further analysis, however, illustrated that this significant decrease in level of knowledge construction disappeared when correcting for task complexity. This finding points at the importance of the task design and task solution support. In this respect we refer to studies that also emphasize the relevance of task instruction (De Wever *et al.*, 2002; Lockhorst *et al.* 2002; Strijbos *et al.*, 2004). The studies demonstrated the beneficial impact of a pre-imposed task structure, fostering role taking during task solution and encouraging student motivation. Previous research of Schellens and Valcke (2005) also revealed that the attainment of high levels of knowledge construction was positively related to the provision of task structure. The latter study showed how a clear task structure fosters task-oriented communication. On the other hand, the study also showed that a too rigid task structure could inhibit specific types of cognitive processing. In the present study, task complexity appeared to be an important task characteristic. When the tasks were too complex the levels of knowledge construction were significantly lower. On the other hand, when the tasks are too straightforward, we might expect that students experience no challenge and the number and quality of the contributions would drop. This presents a dilemma for instructional designers. It appears that *challenge* is an important concept in this context. The learning challenge should be balanced to keep it within a 'zone' that matches the learner's ability (Quinn, 1997). Czikszentmihalyi (1990) refers in this respect to the 'flow state', expanding on the challenge concept. The challenge level needs to be matched to the available knowledge and skills of students.

7.3. *Limitations and recommendations*

The present study can also be criticized due to a number of limitations. First, the research sample consisted of first-year educational science students. It can be questioned whether the findings can be generalized to students in other knowledge domains and to other educational levels. Second, with the exception of the student variable *'learning styles',* the effect sizes of the explanatory variables on both the final exam scores and the levels of knowledge construction were rather small to moderate. Subsequent research with larger samples is necessary to explore whether larger effects can be determined. Third, the question can be raised why the relationship between the different outcome variables (e.g. students' final exam score and levels of knowledge construction) was not investigated by exploring causal paths. A combination of both multilevel and structural equation modelling techniques should be considered in future studies. Fourth, the fact that only one content analysis scheme was used, might be considered as a weakness. However, as part of a dissertation research work, an alternative analysis scheme based on Veerman and Veldhuis-Diermanse (2001) was applied to validate the results. The results of these analyses mirror the present findings (Schellens, 2004).

Future research should focus on larger sample sizes and a wider range of higher education students to get a better understanding of the impact of group, students, and task characteristics on students' levels of knowledge construction and cognitive processing. In this respect, Lockhorst and colleagues (2002) highlight that subsequent research is especially needed with regard to task variables. They state that in the field of CSCL much attention is paid to the cognitive learning processes and outcomes, while too little attention is paid to the influence of task instruction variables.

According to De Laat (2002) a community of practice can be described by the density of the participation within the discussion, the central participants, the activity of the members, and the quality of the discourse. In this research, students' activity (number of messages students submitted to the discussion) and the quality of the discourse (level of knowledge construction in the contributions) was included. However, to gain more complete insight in the community of practice, it might also be interesting to consider the perspectives of 'density' and 'central actors'. In this respect, Preece (2001) also stresses the importance of 'interactivity' and 'reciprocity'. Thread depth, for example, is recommended as a measure of interactivity, whereas measures of reciprocity should take into account the ratio of giving and taking from a community, for example, the number of questions an individual asks compared with the number of responses to others (Preece, 2001).

Notwithstanding the limitations of the present study and the fact that further research is needed, the strengths of the present study are clear. The study was set up in an ecologically valid context and centred on the complex interaction of a large number of variables. The full complexity of collaborative learning in online discussion groups, taking into account student, group, and task variables, was considered.

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Facilitating asynchronous discussions in learning communities: The impact of moderation strategies

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Abstract. A facilitator or moderator is often responsible for supporting processes and their progress in learning communities. In this article we present an approach for supporting moderators of asynchronous processes in learning communities. This approach follows the socio-technical perspective: it includes a theory-based development of moderator tasks and the technical features designed to support these tasks. Starting with relevant work in this area, we describe our approach of moderator support in the collaborative learning environment KOLUMBUS 2. In a qualitative study, a professional moderator facilitated the discussion processes of a group of 12 students based on KOLUMBUS 2. The moderator used different methods and varying levels of participation intervention. The study showed that different intervention strategies led to different levels of student participation and different success in finding common results at the end of the discussions. In addition, suggestions for the design of technical features are described.

Keywords: moderation, facilitation, asynchronous discussion processes

1 Problem

Research on learning communities often refers to the phrase computer supported collaborative learning (CSCL). Carlén and Jobring (2005), for example, describe learning communities as follows:

> ‘Online learning communities facilitate communication between people who share common interests and learn collaboratively using networked technologies.’ (Carlén and Jobring 2005).

In an earlier publication of the series on community-based learning, the editors explicitly describe the relationship:

> ‘The terminological concentration on community-based learning would probably neglect the relevance of the technological support and maybe of spatial distribution as well. The notion of CSCL offered a somehow broader understanding of technologically mediated collective learning processes…’ (Klamma *et al.* 2003).

Based on these observations, we use the term CSCL. The CSCL paradigm is related to constructivism, where learning is an active process of constructing rather than acquiring knowledge (Duffy and Cunnigham 1996). The most important characteristic of collaborative learning is the active role of the learner (Koschmann 1996), which mainly implies participants learn from each other by actively co-constructing knowledge (Stahl 2002). Computer-supported collaborative learning, which in many cases is distributed locally and temporally, mainly focuses on communication, since direct experience of a situation and learning by observation are mostly inapplicable. The more communication that occurs, then the higher the situation is ranked by tutors and researchers (Henri 1995). Some authors even see communication as a precondition for computer-supported collaborative learning (Pea 1996).

If the construction of knowledge is a joint process involving several learners, the main role of the facilitator is to support and inspire the communication processes for knowledge construction. The need to support communication in CSCL processes results in new tasks for the facilitator or moderator (Hansen *et al.* 1999, Kienle 2005). Reasons for this requirement are seen as contingent on fulfilling communication norms and the observation and regulation of discussion focus.

Traditional methods exist for moderating face-to-face settings (Klebert *et al.* 1987). However, it is still unclear how processes in learning communities can be moderated and how this moderation can be supported by a technical system. Friedrich *et al.* (1999) emphasise that the transfer of methods from face-to-face situations to computer-supported situations is not suitable. Furthermore, new methods have to be developed because communication rituals and procedures developed on the fly in face-to-face situations have to be facilitated explicitly in computer-supported situations (Friedrich *et al.* 1999).

In this article we present an approach for supporting moderators of asynchronous processes. Our work follows the socio-technical perspective: it includes a theory-based development of moderator tasks and the technical features designed to support these tasks. Starting from related work on moderation (section 2), we present our approach to moderator support in the collaborative learning environment KOLUMBUS 2 (section 3). In the following section, we present a qualitative study of moderation in asynchronous processes in learning communities (section 4) and its results (section 5). This study also combines socio and technical aspects: we included a professionally trained moderator who was responsible for applying new or common moderator interventions and technical improvements designed to support the moderator. The paper ends with a conclusion and proposed further research (section 6).

2 Related work on moderating processes in learning communities

Most of the present literature on facilitation or moderation in computer-supported settings addresses the concerns of practitioners in the field (e.g. Collison *et al.* 2000, Salmon 2000, Salmon 2002). This body of work describes a moderator's duties and responsibilities in computer supported situations as being very similar to well-known activities from face-to-face situations:

> 'The best e-moderators undertake the ´weaving´: they pull together the participants´ contributions by, for example collecting up statements and relating them to concepts and theories from the course. They enable development of ideas through discussion and collaboration. They summarise from time to time, span wide-ranging views and provide new topics when discussions go of track.' (Salmon 2000)

These findings from practitioners in the field are mostly confirmed by studies on the moderation of online forums (Hammond 1999) or electronic mailing lists (Berge and Collins 2000).

Although the tasks may be similar, it is necessary to develop new strategies when moderating computer supported communication processes:

> 'Moderators must learn new strategies that are appropriate to the online venue, and, through continued practice, study the range of their effects (…) The goal is to help learners as their own thinking evolves' (Collison *et al.* 2000).

Looking at the present literature, we have found little, and sometimes contradictory, advice concerning the relation between moderation of asynchronous processes in learning communities and the well known traditional techniques of moderating face-to-face meetings.

Friedrich *et al.* (1999) conducted a much cited study on moderation techniques, comparing two different methods to initiate a discussion (Friedrich *et al.* 1999). One relied on a neutral opening statement, while the other made use of problem-centric, curiosity-arousing wording when initially characterizing the discussion's objective. They confirmed the assumption that the latter type of discussion initiation results in an increased number of contributions from discussion participants. Furthermore, the fewer statements moderators contribute to the discussion, the greater the number of participant statements.

To summarize our short examination of related work, we can assert that several publications from both practitioner and scientific literature deal with moderating and facilitating computer supported communication processes. However, scientific publications dealing with the transfer and use of moderation techniques in(to) computer supported asynchronous settings are rare, and this forms the starting point for our own work. In what follows, we will focus on the activities of a moderator that concern the initiation, advancement and incidental summarization of a discussion.

3 The support of moderators in the collaborative learning environment KOLUMBUS 2

Although the notion of role-based access control (RBAC), providing a means to restrict access to a system's functionalities and data, is a well-known concept in computer science, to date it has attracted limited interest from the field of learning communities. We argue that collaborative learning environments can benefit from RBAC mechanisms in at least two ways. First, compared to discretionary or mandatory access control systems, the approach advocated by RBAC simplifies the administration of access control rights and makes it less error-prone (Sandhu *et al.* 2000). Second, with RBAC, it is relatively easy to configure a collaborative learning environment's access control mechanisms according to aspects of the operational and organizational structure of the scenario they are intended to support, and thus provide a powerful means of scaffolding use of the system's functionalities in the desired manner. As we have argued before (Kienle and Ritterskamp 2004), we believe that such scaffolding promotes situations in which collaborative learning is most likely to occur (see also Dillenbourg 1999). In order to gain practical experience with the moderation of processes in learning communities, we used the collaborative learning environment KOLUMBUS 2 for experimentation. KOLUMBUS 2 was developed by the University of Dortmund, Informatics & Society and the Ruhr University of Bochum, Management of Information and Technology.

The central feature of KOLUMBUS is segmentation of content into small units (called items), enabling the students to use and annotate the stored content in a very flexible manner. Items can be represented by text, pictures, binaries, links or annotations. Communicative contributions are presented by annotations. The content can be presented as a hierarchical structure of items viewable in a Web-browser. Items of material can be inserted at the same hierarchical level of another item or on the next lower level. In this way the trainer and students can build a hierarchy of their contributions. All existing functions (e.g. annotate, rate, copy, shift, and change) can be applied to every item. Annotations can be inserted on every hierarchical level. The higher they are annotated in the hierarchy, the more general their intention.

Furthermore, KOLUMBUS 2 offers a set of role-based mechanisms tailored to foster cooperation in learning communities. The conceptualization of roles formative to the field of RBAC is of vital importance to these mechanisms. Within RBAC, we can define a role to be a labelled set of privileges (Nyanchama and Osborn 1999). The notion of privileges here refers to whether or not a system permits execution of a specific function, e.g. if a file may be opened, modified or even deleted. We have successfully used KOLUMBUS 2 to define and implement a moderator's role that can exclusively access the following functionalities, which support moderation of asynchronous communication processes:

In a discussion thread, moderator contributions are highlighted with bold type, directing attention of the discussion's participants to the moderator's inputs. In addition to being emphasised, statements composed by the moderator also contribute to the structuring of a discussion at a visual level, reducing the effort necessary to reconstruct the course of a debate when working asynchronously.

Emphasis can be placed on single contributions to a discussion by using a functionality reminiscent of a highlighter: to label an element of a discussion thread, the moderator can choose from a variety of background colours. Marking contributions in this way can be used, for example, to group similar contributions or to accentuate important arguments or to stress (intermediary) results of a discussion. There is no predefined meaning to the usage of different colours: it was intended that a user group negotiate the corresponding conventions without a preceding exertion of influence. Allowing the meaning assigned to each applied colour to be the subject of a preparatory discussion fosters the development of shared understanding of the applied functionalities.

System-internal links are applicable if contributions that are semantically related to each other have to be interconnected. Establishing a relation between elements in such a way is especially reasonable if they deal with similar aspects of a topic but are distributed over several discussion threads not directly connected to each other.

[INSERT FIGURE 1 ABOUT HERE]

It is important to note that the assignment of roles to users is always carried out in a certain context, i.e. one is assigned to a role with respect to a specific subset of the system's content. For example, consider the case of assigning the role of a moderator: instead of choosing a user to be the moderator of all discussion threads in the system, we would rather assign the role of a moderator with regard to a particular discussion.

Besides configuring the RBAC component of KOLUMBUS 2 in such a way that it supports the role of a moderator, we had to extend the system by integrating the aforementioned functionalities that facilitate moderation of asynchronous communication processes. Due to the system's modular architecture, we were to a large extent able to implement these functionalities as discrete components. Having found that the efforts necessary to develop such modules are justifiable, we plan to add further extensions to the system, improving its support for the moderation of asynchronous communication processes.

4 Description of the case study

As known from the literature, moderation in computer-supported situations differs from that in face-to-face situations, although the moderation tasks are quite similar. To tackle this problem we chose a special design for our study. The role of the moderator was taken by a moderator professionally trained for face-to-face settings and familiar with moderation methods and techniques. The moderator's interventions were planned and carried out in cooperation with the researcher experienced in computer supported collaborative learning and work. In this manner, we developed interventions which take into account the specialities of computer supported communication and yet also benefit from traditional moderation methods.

4.1 Aim of the study

The aim of the study was both the development of a hypothesis concerning the methods of moderators´ intervention in asynchronous CSCL-processes and the detection of further requirements for the technical system and evaluation of the KOLUMBUS 2 functionalities described above.

4.2 *Setting*

Between mid-January and mid-March 2005, the moderator facilitated a group of 12 students. This group had the concrete task to document their year's work and can be seen as a learning community. Focus on this group led to a design different from conventional experimental studies in which new groups are formed to work on a virtual task for a short time. Discussion about the composition and content of the documentation, as well as the writing process, took place in a moderated working area of KOLUMBUS 2. The task was divided into five steps. For each step, the moderator planed interventions in cooperation with the researcher. Table 1 shows the steps and three examples of interventions for which results will be shown in the following subsections.

[INSERT TABLE 1 ABOUT HERE]

The moderator and researchers met twice a week to plan and carry out interventions. The students were not informed of the dates of these meetings.

4.3 *Collection and analysis of data*

Moderator and researcher meetings were recorded as an audio file and video screen capture. Quantitative data about the student group was gathered by logging all events in KOLUMBUS 2. Furthermore, qualitative data was recorded on an audio file at group interviews conducted every two weeks.

The audio files of moderator meetings and group interviews were analysed with respect to moderator intervention methods and their implications on group behaviour as well as the technical support and its further improvement. The evaluation of the log files was conducted using a tool for such analysis (Projektgruppe 454 2005). The KOLUMBUS analytical tool is a prototypical KOLUMBUS module that supports the analysis of logged events in the related KOLUMBUS content area. Authorized users select persons from a list of participants, actions from an action list (e.g. annotate, add text or documents, download), and time periods. Results are shown as tables and graphs. The following figures were generated by this analytical tool.

5 Results

Results of this analysis are presented in this section. These concerned the moderator's interventions and suggestions for design of the technical system. Results referring to the strategies of intervention are presented to good effect alongside the selected interventions shown in Table 1.

5.1 Interventions of the moderator

5.1.1 Open questions without any instructions

At the beginning of the study (see step 1 in table 1) the moderator asked open questions, similar to that of traditional moderation in face-to-face settings. This especially means that the students had to decide which functionalities they used and when they answered the question. Figure 2 shows student participation. Here, as well as in the following figures, each line corresponds to a student and shows the number of his/her annotations during a period of time (mentioned in the title of the figure). Usually names of the students are shown in a legend at the right side, but they have been blanked out for this paper to respect anonymity.

[INSERT FIGURE 2 ABOUT HERE]

In the first group interview the students were asked to give reasons for low participation, reporting their uncertainty concerning when and in which form answers were required. Furthermore, they described obscurities concerning the (subjective) cognition of the progress of a discussion thread, especially when a discussion was finished. Following these answers explicit dates were demanded:

> 'We could think about finished discussions at a certain date, in a week, a half or so. Then one has an overview, then one knows at that date nobody will add more contributions.' (student, interview Jan, 13th, 14:50 min. Cit. translated by authors).

5.1.2 Instruction, deadline and finalizing conclusion

In step 2, the moderator used more instructional contributions that included deadlines. This led to higher participation levels in the discussion (see figure 3). This reveals for the first time that students worked in a rhythm similar to that given by the moderator: on deadline days at the days more contributions were added.

[INSERT FIGURE 3 ABOUT HERE]

As known from traditional moderation methods, the moderator gave a summary after the deadline passed and asked for further comments. Reaction to this query was reduced. In the following group interview students complained that with such questions the discussion was terminated:

> 'The date was Friday for the table of contents and then the moderated asked for further comments […] I missed that someone on Friday says: ok, this is our table of contents and now lets go further and coordinate our group work on the content. Instead of that we were asked for further comments which would not lead to an end'" (student, interview Jan, 27th, 2:24 min, cit. translated by authors).

This is the first difference, compared to face-to-face settings, in which queries are a widely accepted technique. Students were of the opinion that every discussion participant in computer supported asynchronous settings has the opportunity to contribute due to the longer period of time. Therefore, no further comments should be solicited in the asynchronous environment compared to the face-to-face one.

Reviewing the content and results of the discussion, we must concede that the initial aim of aim of generating a collaboratively developed table of contents accepted by all group members was not achieved in the computer-supported discussion. Students reported different problems in the group interview. The first was the starting point of students´ participation in the discussion:

> 'At that time a new topic or question of the moderator arises and nobody has yet contributed, the temptation to wait to see what others were going to add was great.' (student, interview Jan, 27th., 8:50 min, cit. translated by authors).

A second problem concerned concurrency of opinion, which proved to be unmanageable in the system:

> ‘When others have written something and I agree with them, then everything has been said’. (student, interview Jan, 27.th, 9:12 min, cit. translated by authors).

This shows the limitations of the technical system used, KOLUMBUS 2:

> ‘Simple agreement - in face to face situations with the head nodding and everybody see these agreements – this is not possible in the computer supported asynchronous setting.’ (student, interview Jan 27th, 9:48 min, cit. translated by authors).

Taken together, it was clear that although participation was high, discussions were not terminated in the computer-supported discussion. Students felt termination or finalizing should be done by the moderator.

5.1.3 Conclusions with decisions by the moderator

In a third step, the moderator intervened more than during previous steps. They not only formulated more instructional contributions, which included deadlines, but terminated discussions. If some topics did not come to an end by the deadline the moderator decided and proposed a solution. This is a second aspect of computer supported asynchronous moderation that differs from a face-to-face situation where the moderator is not responsible for the content of the discussion or the group result.

[INSERT FIGURE 4 ABOUT HERE]

A high level of participation was recorded in this step (see figure 4); once again, the participation was highest on deadline days. A closer look reveals an interesting observation: specifying an hour led to high participation, especially in the minutes just prior to the deadline (see figure 5). This is shows that students followed the rhythm set by the moderator.

[INSERT FIGURE 5 ABOUT HERE]

The discussion in this step led to the aim of coordinating tasks for writing the group documentation. During the group interview the students confirmed that the ‘*point of going further*’ was achieved by the moderator’s intervention.

5.2 Further requirements for functionalities supporting moderation processes

As we have already illustrated in section 3, KOLUMBUS 2 currently supports moderation of discussions primarily by visually accentuating a moderator's statements, offering the possibility of emphasizing selected contributions using a highlighter and facilitating the establishment of a connection between any two (semantically) related elements (e.g.: discussion threads) by system-internal links. We have gained valuable feedback on the design and usefulness of these functionalities from the case study conducted.

Students affirmed that placing emphasis on a moderator's statements by applying bold type to them proved to be helpful in following the course of a discussion. Since the contributions of a moderator often brought up a new topic, and thus resulted in a new discussion thread, emphasizing them pointed up the structure of an extensive discussion more clearly. For instance, if two moderator statements were displayed, one below the other, topics not yet discussed became apparent rapidly.

Although it would have been useful to label similar or agreeing proposals when students were collecting ideas for the outline and content of the documentation they had to compose, in our case study the moderator did not apply the highlighter functionality to draw attention to single contributions. Investigating possible reasons for this behaviour, it turned out that they considered the design of the highlighting mechanism too coarse-grained, as only the entire contribution could only be highlighted. In this context the moderator referred to a technique known from moderation of face-to-face meetings whereby crucial points are committed in writing to cards that can be arranged on a pin board. In these situations, one does not put down complete statements but confines oneself to recording only the most important keywords. According to this, calling attention to a whole contribution in a discussion thread by highlighting it proves to be an inappropriate means if one only intends to underscore essential propositions. We can derive an initial suggestion for improvement from these findings: instead of being restricted to the level of items, subsequent versions of the highlighter mechanism described here should be applicable in a more fine-grained manner (i.e. facilitating the selection of single words) in order to allow for a precise accentuation.

Since there was no situation where similar aspects of a topic were addressed in various discussion threads, there was no need to connect semantically related contributions using system-internal links. Thus, the corresponding functionality remained unused. We assume that these observations do not reflect the normal case and ascribe the participant's strict adherence to a preliminary agreed-upon agenda to mature interventions brought in by the moderator in early stages of the discussion. Consequently, we still advocate that system-internal links may be a beneficial means when moderating asynchronous discussions of learning communities.

During the study, the moderator made proposals for further functionalities aimed at improved support for activities typical to the moderation of both face-to-face and computer supported discussions. First, a moderator should be able to '*assign questions and work orders individually'* by means of a collaboratively shared task list. Supporting the assignment and handling of tasks is closely related to functionalities fostering the participant's awareness of the current state of the collaborative process in which they are involved. Furthermore, the moderator asked for a means to support synchronous voting in order to speed up the process by which participants reach a group decision. The students participating in our study also identified functionalities and qualities of a system that are relevant to the support of moderated discussions. Primarily, sophisticated awareness mechanisms notifying the users automatically of relevant events (e.g. if somebody comments on one's own contributions or if a voting process is initiated) and short system response times were demanded. Moreover, a mechanism providing an overview of a discussion's current state as well as a straightforward functionality to express one's agreement to a proposal was considered a helpful extension to the system.

6 Conclusion and further work

In this paper, we have examined the moderation of asynchronous communication processes in the field of learning communities. Starting from an analysis of related work, we described our approach for supporting activities related to moderation in collaborative learning environments and exemplified its practical implementation with reference to the collaborative learning environment, KOLUMBUS 2. We then presented the results of a qualitative case study assessing both the applicability of our concept and its potential effects on collaboration.

Interviews with the study's participants and analysis of system log files provided first insights on the impact of the different strategies and functionalities we employed to support moderation. For example, if the moderator used instructive wording when formulating their contributions and appoints deadlines for the completion of tasks, participation initially increased. However, this was not sufficient to foster the development of mutually agreed upon results, e.g. a task list or an outline of an article that had to be written collaboratively. Findings from our case study suggest that for this purpose a moderator occasionally has to make decisions on their own and needs to present intermediary results in condensed form. This conclusion is contradictory to the outcomes of other studies cf. Friedrich *et al.* (1999). Compared to face-to-face situations, a moderator is to a greater extend involved in activities concerning decision making and leadership when moderating asynchronous computer-supported discussions. As a further step we plan to conduct an experiment to verify strategies for moderating CSCL processes proposed in this paper.

With the objective of improving the support for moderation in predominantly asynchronous processes in learning communities, we currently implement the requirements that arose in the course of the case study. For instance, we are integrating rating and negotiation functionalities into KOLUMBUS 2 to improve support for group decision processes. In addition, we plan to incorporate shared task lists and reflect on context-sensitive mechanisms providing a moderator with hints on suitable strategies for intervention. With these functionalities in place and the system adjusted to the requirements illustrated before, we intend to conduct a subsequent case study to evaluate their usability.

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[FIGURE AND TABLE CAPTIONS]

Figure 1: Moderators´ functionalities in KOLUMBUS 2 (contributors' names blanked out).

Figure 2: Participation in open questions (Annotations from 2005, Jan. 10th until 2005, Jan. 13th).

Figure 3: Participation in the condition instructional question (Annotations from 2005, Jan. 13th until 2005, Jan. 25th).

Figure 4: Participation in step 3 (Annotations from 2005, Jan. 28th until 2005, Feb. 3rd).

Figure 5: Example for the development of rhythm (Annotations on 2005, Jan. 31st).

Table 1: Steps of the group work and interventions of the moderator.

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Reality is our Lab:
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.

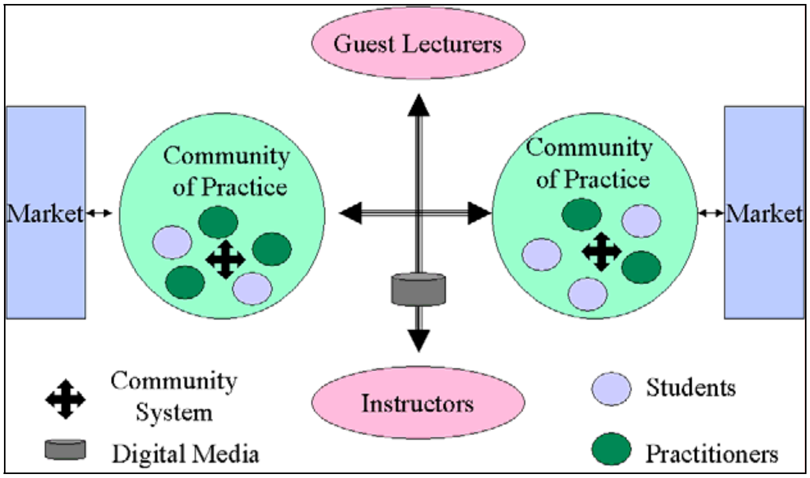

Figure 1: Design of the computer supported course 'Entrepreneurship and New Media'

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>
<tr><td colspan="5">Table 3. Participants and Roles in the second course (2002)</td></tr>
<tr><td></td><td>Students</td><td>Entrepreneurs</td><td>Tutors</td><td>Instructors/Teachers</td></tr>
<tr><td>Lab 1</td><td>4 Indian Students (male)
1 Ghanese Student (male)
1 German Student (male, left the group)</td><td>1 Supervisor</td><td>1</td><td rowspan="3">2 from University,
6 extern Practitioners (Business Angels, Personal Manager, Marketing Experts etc.),
6 Students of Psychology, teaching Presentation Techniques</td></tr>
<tr><td>Lab 2</td><td>4 German Students (1 female, 3 male)
1 Greek Student (male)
1 Turkish Student (male)</td><td>1 Supervisor</td><td>1</td></tr>
<tr><td>Lab 3</td><td>2 Indian Students (male)
1 Pakistanian Student (male)
1 Turkish Student (male)
2 German Students (male)</td><td>1 Supervisor</td><td>1</td></tr>
</table>

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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