The Power of Media in Education

-NBE 2007 Conference

Rovaniemi, Finland 13-15 June 2007

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(Eds.)

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Preface

Dear NBE 2007 Conference Participants,

We are pleased to welcome you all to the second NBE 2007 international conference *The Power of Media in Education* organised during the days of 13-15 June in Rovaniemi, Finland. The first NBE Conference was held in Rovaniemi at the University of Lapland in the year 2005 (http://www.ulapland.fi/nbe2005). The first conference turned out to be an informal and friendly gathering providing participants with rich opportunities to exchange ideas and information about technological tools in education, teaching and learning in novel learning environments, and about media education. We hope this tradition will continue to flourish during the present conference.

We have a great privilege to host widely recognized experts as our keynote and invited speakers. We are grateful to Professor Paul Kirschner from Utrecht University, The Netherlands; Associate Professor Ricki Goldman from New York University, USA; Associate Professor Cindy E. Hmelo-Silver from Rutgers University, USA and Lecturer Jonathan Foster from University of Sheffield, UK. Thank you for your willingness to share your expertise and insights with the whole conference community.

The organizing committee of the conference received 21 paper submissions out of which 12 passed the review process, the acceptance rate being 57 %. The core themes of the accepted presentations are: *(a) ICT in Teaching and Learning, (b) Technological Tools in Education; (c) Play and Game-Based Learning; and (d) Mobile Technologies in Teaching and Learning.* These themes also guide the structure of the whole conference program.

We are grateful to the reviewers of the conference submissions for their intellectual commitment and sustained work in ensuring the scientific quality of the conference program. Our special thanks also go to Ms. Merja Koriseva for her important work in the graphic design of the conference materials. Finally, we would like to recognize the significant role of our sponsors who have believed in the importance of our work in organizing the present conference. The sponsors are the Academy of Finland, CICERO Learning, City of Rovaniemi, Doctoral Programme for Multidisciplinary Research on Learning Environments, Lappset Group Ltd and WebSeal. We appreciate you all.

The venue site for the NBE 2007 conference is exotic and unique. The University of Lapland is the northernmost of all universities of the European Union. Moreover, the city of Rovaniemi is generally considered as the Gateway to Finnish Lapland. This northern area has always been at the crossroads of the past and future, characterized by rich cultural heritage as well as technological achievement and civilisation. The conference site will thus offer us an exciting intellectual setting to meet, share, and learn from one another.

We sincerely hope you will enjoy the conference. Welcome!

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Professor Heli Ruokamo, Chair
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Table of Contents

Play and Game-Based Learning

Mobile Technologies in Teaching and Learning

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Keynotes

Video In-Sites: Orion™ for Sharing Perspectives & Changing the Nature of Knowing

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Sharing perspectives to gain insights from video "data" is a critical part of the research and learning process. Moreover, the Points of Viewing Theory—a theory that overcomes the static, isolating, individualized approach of point of view, in favor of the dynamic tension that operates among points of viewing, points that generate intersecting *sight-lines*—enables people to catch sight of each other, as interpreters, even as they project their own point of view on what they are learning. In this paper, I discuss the methodological approach called the Perspectivity Framework to demonstrate how video data creates social connectivity knowledge. I argue that a theory and methodology for sharing perspectives not only enables learners, teachers, and researchers to understand how the appreciation of each other's selections, interpretations, and decisions about the topic they are studying is beneficial, but also how both the theory and method are enhanced by using a video-based social connectivity platforms. In these emerging networked environments, traditional knowledge boundaries are crossed. Using Orion™, one such video data analysis and social connectivity environment, learning cultures can be woven together as knowledge embedded in video is shared, interpreted, and reconstituted. This is not a revolution. Not a paradigm shift as Thomas Kuhn called these shifts. Instead the changes we are now experiencing are gradual *evolutions of overlapping* genres where each genre also connects with the other as people interact within virtual visually-based spheres we are only beginning to understand.

Keywords: perspectives; video; research; learning; video tool; Orion™; evolution

1 In-Sites Using Video

As we know from the recent ubiquity of online digital video, video has become a compelling tool for educational representation. Students use it in their projects; teachers and pre-service teachers use it to study pedagogy; and, researchers use it for capturing and examining how learning happens, as they unfold. However, one has to ask what larger frameworks are at play. Do digital videotexts offer insights that act as change agents in educational settings? I propose that they provide an enhanced experience of both personal and shared perspectives, an experience that builds the Perspectivity Framework. This framework lays the foundation for an evolving transformation in education. Where education has been mostly concerned with improving instruction and construction of knowledge within disciplinary boundaries, education has shifted toward improving communication methods, tools, and strategies across disciplines. Video is more than a tool for instruction or construction; it enables the sharing of perspectives about knowledge. It creates a heightened sense of immediacy, presence, and networking. It expands the possibility of reviewing events that can lead to creating a generation of epistemologists. In short, digital video provides learners, teachers, and researchers with a powerful method of reflecting upon and negotiating meaning within a culturally diverse social network.

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People often ask why learners and teachers—not only researchers—need to work with video. How can we possibly take what precious time we already have in schools as learners (hopefully) become literate in many knowledge domains, and ask students to work with video within that time? What possible educational value can video have, except for those who will become video artists or enter the entertainment industry?

Researchers have shown great interest in exploring the educative value in games and game-like environments starting with Logo, NetLogo, and Scratch—as tools for learning how to program (Blikstein, Abrahamson, & Wilensky, 2005; Kafai, 2006; Kafai, Resnick, 1996; Peppler & Kafai, 2006a & 2006b). Researchers have also explored how gaming impacts learning in a general sense and in specific learning domains. For example, Fudenberg and Levine (1998) examine the theory of learning in game and how learning happens in the gaming environment; Gee (2003) investigates how video games promote literacy acquisition and learning; Prensky (2004) examines how learners have changed in the games generation; Johnson (2005) argues that that playing video games actually make us smarter; and Squire (2002) reminds us of rethinking the role of games in education. In one of his recent research, Squire (2005) examines how videogames enter the classroom and change the traditional way of teaching and learning.

However, researchers have failed to address how using (selecting, uploading, tagging, and analyzing) personalized and shared video change educational practices. Perhaps it has seemed like an activity for video professionals only. The use of video once conjured up cramped editing rooms with tapes piled high on flat surfaces and video editors sitting in darkrooms for days. Now, video is no longer restricted to a video-editing suite. It has become integrated with of every other bit and byte on the computer. Moreover, the video camera has become almost as ubiquitous as the digital camera and the cell phone. In fact, the cell phone can record video images easily uploaded to the web. Routinely, people videotape the mundane and the exotic. They videotape an approaching subway, the stream of people on elevators in train stations, and each other while they talk. The current global technological obsession is the desire for interactive, personalized, and shared records of our experiences. And, we want to be able to share these experiences anywhere anytime.

Sitting on a mountain peak at Whistler, British Columbia, a young couple views their video on a small 2-inch by 2-inch built-in monitor rather than looking at the expansive landscape in front of them. When they move away from their perch, our eyes make contact and we exchange pleasantries. We chat about the beauty of the Blackcomb mountain range. After explaining to them that I am a videographer and am curious about what they were viewing, they, a bit embarrassed about an outsider having observed them, explain that sharing the video on this inspirational spot makes them feel closer to each other. They like sitting close, watching their video of themselves and the mountains. They also tell me that they like talking about what parts of the video they liked the best—to share their experience and reflect "on the ground" as it were, the meaning of their experiences. They also tell me they didn't want to "miss anything" as they would not be back for a long time. And, (more giddily) they want to see how they looked in that spot. How their partner filmed them within the remarkable landscape. So, the video is not simply a tool for transferring information or even for constructing new knowledge. It is a framework for sharing perspectives on the known and for negotiating the unknown.

In short, video is here and it is everywhere. On iPods, on cell-phones, and on any other media device we carry into schools, homes, trains, or planes. We want to view things, sometimes over and over, especially if we shot them or are "actors" in them. We want to make selections of things we liked and send them to each other. And, for some of us, we just want to know that we were there and that those moments are saved (somewhere), in our archives as messy or organized as they may be, so that later, at some time down the road, when we want to see ourselves on the mountain top again, we can take the time to think about how those moments, those precious moments, were spent and what larger meaning they had in this journey through life as we learn more about ourselves, others, and the world around us.

Shooting, selecting, and using video and other visual media on a range of media tools is not only a romantic quest for saving the moment and sharing it on a mountain top. My example is meant only to suggest that video is so pervasive that is impossible to escape its lens, whether the camera is in our homes, schools, or walking into the airport. When we invite the camera in to document what is occurring or when we select the video for use in our learning, teaching, and research, it changes those environments fundamentally. What was once private is immediately public. So the question is not if video is going to be used, it is how video can be used for our benefit rather than as yet another surveillance tool watching over our activities and erasing any semblance of private space. To think about the use of video in education, one must consider not only the best cases, but also how to prevent the worst cases from occurring. And for that, we need to build upon a framework that will enable this technology to be used for the benefit of learning, teaching, and research.

2 The Perspectivity Framework

Perspectivity frames how learners, teachers, and researchers make meaning of events from both individual and multiple *points of viewing* (Goldman-Segall, 1998). Also see: http://www.pointsofvewing.com. It also provides us with a tool to take advantage of the richness of individual and diverse perspectives as we select, analyze, and construct media, particularly video, on and for iPods, handhelds, and online learning environments. The Perspectivity Framework has previously been defined as a research approach for making meaning of digital video data by layering multiple points of viewing (Goldman & Maxwell, 2002). The video data become robust as meanings are negotiated, layered and saturated with implication and significance. The layering can occur with an online video analysis tools, such as Orion™ (Goldman, 2007) or other video data selection and analysis systems (Stevens, 2007; Pea et al, 2007). It can occur without these technologies, of course, but the technologies act as *tools to think more deeply about the process.*

The perspectivity framework is also a methodological framework for learning, teaching, and researching based on the points of viewing theory. As I wrote in a recent chapter on the tool, Orion, in *Video Research in the Learning Sciences* (2007)...

> *The points of viewing theory* (POVT) has at its heart the intersecting perspectives of all participants with a stake in the community. It is a theory about how the interpretive actions of participants with video data overlap and intersect. To embrace how these points of viewing converge (and diverge) leads to a deeper understanding of, not only the event and the video event, but also the actual physical and the recorded context of the topic under investigation. The points of viewing theory overcomes the static, isolating, individualized approach to point of view, in favor of the dynamic tension that operates among points of view, points that generate intersecting sight-lines, enabling people to catch sight of each other, as interpreters, even as they project their own point of view. In this way, POVT underscores the importance of attending to how others project meaning on events. While attending to intersecting data of viewer and viewed, every interpretive action has the possibility of infusing meaning which creates new representations that, if carried out with sensitivity, tenderness, and humanity, resonate with the reasonable nature of members of a larger community. (Goldman, 2007, p. 508.)

The perspectivity methodological framework (Goldman and Maxwell, 2002) maintains that advanced video technologies offer a larger range of possible interpretations on what occurred in a given setting, knowing that every stakeholder has a different viewing of the event—a viewing that affects changes in perception as the video is shared, annotated, and put into new configurations within social networks. The perspectivity framework also describes the benefits of seeing and understanding events from multiple points of viewing; these multiple points of viewing provide learners with a clearer understanding of complex situations. It provides learners, teachers, or researchers to "see" that all knowledge is, at best, partial and emergent (Clifford, 1986). Thirdly, the perspectivity framework underscores how video is an epistemological tool, perhaps a better tool than the written language enabling learners to communicate and share what they are making, doing, and thinking during their process of learning. In other words, using video and this framework enables a shared space for exploring the process of knowledge construction.

3 The Highly Visual Evolution

Starting with Apple's release of HyperCard™ in the late 1980s, learners have been able to integrate a variety of digital media forms into documents. Multimedia, hypermedia, new media are the terms we have used to describe this use of visual media in learning. Of course, this is not the beginning of our use of a variety of media to learn. People have always used diverse visual media to communicate with each other and learn (Gordon, 1977; Levinson, 1997). Every written language is a visual representation, like an ever-changing vessel that holds the accumulated communication and learning of communities, peoples, and countries. Written words (also visual media, to some extent) stand for sounds, objects, ideas, and ways of presenting and marking in stone that which was fleeting and ever changing (Sanders and Illich, 1988).

In prehistoric times, we communicated our needs, ideas, experiences, emotions, or interpretation of events with sounds, gestures or simple "tools" such as stone, parchment, or any object or expression that could be manipulated to convey a message. The purpose was to enable others to "view" or share our experience. The use of simple tools-made objects enabled knowledge to be "captured" in a form that stood for something other than the material from which it was created. In other words, they became a representation or an artifact of the thing it stood for. In short knowledge could be transferred and, if compelling enough it would be selected by others as significant and meaningful for their own knowledge and communication processes. And, then, of course, each communication act would build multiple interactive episodes that created, not only layers, but also patterns of interpretations and creations that could be recognized by others within genres and classifications. As we know, within time, one such expressional object (artifact) could stand for an entire discourse community or several interconnected ones—for example, the golden calf, a painting of a pond with water lilies, or a specific hand gesture.

Knowledge gleaned over centuries suddenly became accessible to those who could afford to acquire mass produced books instead of ones that were painstakingly word-for-word hand-written. One could infer that the institutionalization of public schooling, an institution that has primarily used the written document in almost every aspect of transmitting and testing learning, would most probably have not emerged without the Gutenberg Revolution as Jenkins (2004) and most other media scholars have pointed out (Moos, 1997; Thorburn & Jenkins, 2003).

New media, particularly broadband digital video with its richness for viewing the actions of real events and for presenting stories, has now captured the imagination of educators—not simply as a supplement to fill in time at 2:00 pm on a Friday afternoon as was the case in the latter half of the 20th Century when teachers would show films to their classes, but rather, as a rich environment for viewing, reviewing, annotating, and then selecting elements or chunks for future use in a larger dynamic and interactive project. The oddly coherent nature of new visual media, even in its raw form with no editing, enables viewers to feel like one is present (Mizoeff, 1999) and that there is here, whether we are in the process of learning, teaching, researching, or at play. Clifford Geertz (1973) and other anthropologists refer to this phenomenon as "being there." It is what ethnographers (who were yet influenced by postmodernity) tried to create in the construction of written texts. Using video, for example, creates this sense of presence, immediacy, and engagement; it is part of the nature of the medium. Using the digital camcorder, we place ourselves into a visual display in much the same way that Woody Allen presented in his movie, *The Purple Rose of Cairo.* Like Jeff Daniel's character, the dashing Tom Baxter who walks off the screen into the arms of Mia Farrow's character Cecilia, we think that the visual boundaries are permeable. We not only think that we can change events by infusing our interpretation upon what is recorded, and, we also think that by our virtual presence, we affect a change in the story on the screen—if not for others, then certainly for ourselves. We read ourselves into the visual experience in a way that is probably more powerful than the way we read ourselves into a novel or a musical experience.

However, it is not only learners who learn from the use of video and other visual media forms. Teachers use it to improve their pedagogy (Teachscape, 2000; Derry, et. al., 2002) and to create a *professional vision* (Sherin, 2007); and pre-service teachers use video to study how other teachers work in problem-based environments (Derry, & Hmelo-Silver, 2002). Moreover, a growing community of educational researchers in the learning sciences use video for capturing the events in learning settings to better understand the nature of the learning process (see *Video Research in the Learning Sciences* by Goldman, Pea, Barron, and Derry, 2007). Video technologies create a visually compelling context for interpreting meaning. They also enhance our "e-motion" through complex topics. Moreover, they expand our ways of communicating, providing us with the feeling of being present with others.

We think we know how to view video. More or less. We seem to know how to conduct some reviewing and analysis of video data. For example, Bodker (1995) proposes applying the activity theory to video analysis. Jacobs, Kawanaka and Stigler (1999) propose a cyclical analysis process to analyze video data. In the early research conducted by Adams and Biddle in 1970, they display the picture of how video was used in teaching in 1970s. They also predict that video be widely used in educational settings. Later research approves the prediction. For example, Foster (1984) explains how video is used as an educational research tool. We also have some good examples of how it has been used in both school-based learning (Abell, 1996; Derry, 2004) and in informal settings (Barron, 2004). There are also examples of how it has been used for teacher preparation programs (Goldman & Barron, 1990; Stephens, Leavell, Fabris, Buford, & Hill, 1999). To some degree, we can predict what tools may aid us in our future indexing and searching (Goldman, 2007; Goldman & McDermott, 2007; Goldman-Segall, 1993; Goldman Segall, 1989). But, do we really understand its slippery nature and how to convey the meaning of what was experienced when the camera was turned on? Do we really know what to delete, what to showcase, what tags to use, what grouping to make from our collections that explain or communicate meaning? We need to not only look in our sites, our websites, and understand these elusive segments of video data, but we need to develop the sensitivity to gain *insightfulness.*

4 Orion™ for Sharing Video of Learning In-Sights

To be presented at the conference keynote address.
Orion can be found at http://www.videoresearch.org.

5 In-Sites

The studies I have conducted over the past two decades show how learners, teachers, and researchers in video cultures experienced an enhanced sense of immediacy and agency, and a deeper appreciation of their own perspective and the perspective of others. Moreover, one can clearly see how they learned to appreciate each other's viewpoints, a trait we should all hope children (and adults), as global citizens, might learn as they learn to work together in every walk of life. These studies provide us with qualitative evidence that our interwoven learning cultures are on the edge of a major shift as more and more knowledge construction is "related to" the selection, interpretation, and construction of knowledge using these rich video mediated texts. It is not a revolution that we see. Not a *paradigm shift* as Thomas Kuhn (1970) might have called it, and not exactly how Lev Manovich (2001) refers to the continuity of media forms, but rather an evolution of overlapping genres, each interacting with the other as we move from stone carvings to virtual video-based game worlds for exploration and connoisseurship.

My vision for the future is that learners, teachers, and researchers in distributed communities will gain knowledge and tolerance of diverse ways of living through learning about each other. It strikes me as not an accident that the word vision is about seeing—our *vision*, and that the word *theoria* once meant a viewing. In creating a shared vision for educational change, we will continue to build upon existing educational theories and create even more compelling digital video representations and illustrations of what we understand, thereby providing valuable insights into the range of possibilities in the learning process.

As participating members of video-based learning cultures, we, as educational researchers, teachers, and learners, can now gain deeper, richer, and perhaps more valid windows into our own and each other's thinking processes using these video records and video texts. And this reflective insightfulness could change education in ways that we could not have foreseen before the digital video evolution.

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The Power of Technology to Support Complex Learning

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In an increasingly complex world, learners need to be able to engage with complex phenomena. Such phenomena are critical to understanding the world but to learn about them, one needs to engage in complex, meaningful tasks. Such tasks are difficult and require scaffolding to help learners engage in the tasks and learn from them. This paper will consider how technology can provide support for complex learning and provide examples of software designed to support and scaffold complex learning.

Keywords: scaffolding, simulations, video, complex learning, problem-based learning,

1 Complex Learning

In an increasingly complex and changing world, people need to be able to go beyond learning the knowledge and facts in a domain; they also need skills and dispositions for lifelong learning, reasoning, and problem solving (Fischer & Sugimoto, 2006). But engaging with complex phenomena is difficult, and may impose excessive cognitive load that could overwhelm the learner (van Merriënboer, Kirschner, & Kester, 2003). What then is the solution? One approach is to simplify the task; another, advocated here is to provide scaffolding that can help learners manage the complexity (Hmelo-Silver, 2006; Hmelo-Silver & Azevedo, 2006). Technology has great potential to provide rich contexts for complex learning and needed scaffolding.

Complex learning is often situated in inquiry learning (IL) or problem-based learning (PBL) contexts (Hmelo-Silver, Duncan, & Chinn, in press). In these contexts, students learn content, inquiry practices, reasoning strategies, and lifelong learning skills through collaborative problem solving, reflection and participation in inquiry. These approaches are organized around relevant, authentic problems or questions and place heavy emphasis on collaborative learning and activity. Students are engaged in sense making, developing evidence-based explanations, and communicating their ideas. The teacher plays a key role in facilitating the learning process (Hmelo-Silver & Barrows, 2006). A PBL problem for pre-service teachers might ask them to redesign or adapt instruction (Derry, Hmelo-Silver, Nagarajan, Chernobilsky, & Beitzel, 2006). IL environments such as the Web Integrated Science Environment (WISE) provide students with scientific problems and research materials that students examine to reach a conclusion about the problem (Linn & Slotta, 2006). However, students need help and support to learn in these environments.

If learning is so difficult in these environments, then one might ask why bother? Certainly if the goal of education were merely to equip students with discrete bits of knowledge, then these situated approaches to learning might not be worthwhile. However, if the goal is to prepare learners with useable knowledge and soft skills such as reasoning and lifelong learning skills, then preparing people to deal with complex phenomena and ill-structured problems is important (Abrami, 2001; Derry & Fischer, 2007; Fischer, 2007). As Kuhn (in press), Fischer (2007), and others have argued, learners need to be prepared for a changing world in which knowledge is changing, may not be applicable in straightforward ways (Spiro, Coulson, Feltovich, & Anderson, 1988) and may require integration of theoretical and case-based knowledge (Kolodner, 1993). Learning environments need to provide opportunities and scaffolding for learners to develop these kinds knowledge, skills, and dispositions.

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2 Scaffolding Complex Learning

In environments that support complex *learning,* students often learn through engaging in some consequential task. The challenge then is to provide scaffolding that allows them to competently do the task while also learning from that task. Scaffolding is built on the notion of a *zone of proximal development*- the zone of activity in which people can perform tasks with assistance that they could not do by themselves (Vygotsky, 1978). There are several ways to scaffold complex learning. One way is to structure the task so as to channel the learner's actions by highlighting relevant task features and constraining what they can do (Pea, 2004). This does not necessarily make the task simpler but increases the likelihood that the task will be achieved. Structuring helps guide learners through key aspects of tasks as well as supporting planning and performance (Reiser, 2004). Alternatively, scaffolding may actually make the task harder (Reiser, 2004). This *problematizing* can help learners engage in constructive processing as they think about key content , epistemic practices, and strategies (Chi, Siler, Jeong, Yamaguchi, & Hausman, 2001).

Here we consider primarily three kinds of scaffolding (Collins et al., 1989; Hmelo-Silver, 2006).

1. Communicating process involves presenting the process to students, structuring and sometimes simplifying the process. This can occur through modelling a process. Structuring the process means defining the stages of an activity whereas presenting it involves explicitly providing the students with the stages of an activity.
2. Coaching entails providing guidance to learners as they perform a task. This can be accomplished by highlighting critical steps of the process as students are working on a problem. Coaching can include statements that help frame the problem and articulate the goals (Hogan & Pressley, 1997).
3. Eliciting articulation is asking the student to explain (to themselves or others) to encourage reflection. This can help enhance constructive processing (Chi et al., 2001), make thinking visible, and consequently, open for discussion and revision.

These approaches to scaffolding are grounded in social constructivist theories, which place a strong emphasis on discourse structures that support instructional conversations (Palincsar, 1998). For example, in problem-based learning, facilitators use a variety of discourse strategies to scaffold collaborative knowledge building as they engage with complex phenomena (Hmelo-Silver & Barrows, 2006). Many of these scaffolds are integrated into technology-based

3 The Role of Technology

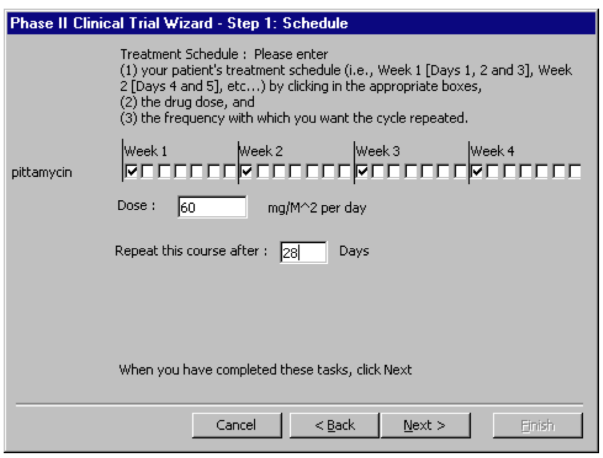
Technology has (at least) four major roles in supporting complex learning (Goldman-Segall & Maxwell, 2003). The first is providing a rich context for learning, such as new media might provide. Such contexts might include digital video cases or computer simulations (Derry et al., 2006; Gredler, 1996; Hakkarainen, Saareleinen, & Ruokamo, in press). These contexts provide opportunities for students to view and re-view complex phenomena, such as video of a classroom. Simulations provide opportunities for learners to observe, conjecture, and test ideas about phenomena. They may also scaffold learning through presenting models. The second is providing spaces for students to collaborate. These might take the form of threaded discussions, chat rooms, or online whiteboards. Different kinds of collaboration spaces have affordances for different aspects of collaborative activity as they elicit articulation and support reflection (Hmelo-Silver, Derry, Woods, DelMarcelle, & Chernobilsky, 2005; Stahl, 2006). Third, technology can provide access to and structure information in ways that promote particular kinds of knowledge organization (Azevedo, 2005; Spiro, Feltovich, Jacobsen, & Coulson, 1991). Hypermedia, internet, and databases are examples of such tools. Their organization helps scaffold learning by providing models of expert knowledge organization.

Fourth, technology can provide scaffolding through tools that help learners both accomplish the task and achieve their learning goals, such as tools that support collaborative knowledge building and reflection. This may include representations that model particular kinds of reasoning processes, activity structures that communicate approaches to problem solving, and prompts that are designed to elicit articulation. The first two of these help decrease cognitive demand by providing models and external guidance for students that help structure the activity. Eliciting articulation may play the role of problematizing by asking learners to think about what they are doing and thus promote knowledge construction. The next sections presents three design studies that exemplify how technology was used to support complex learning in domains ranging from designing clinical trials to aquatic ecosystems to classroom application of the learning sciences.

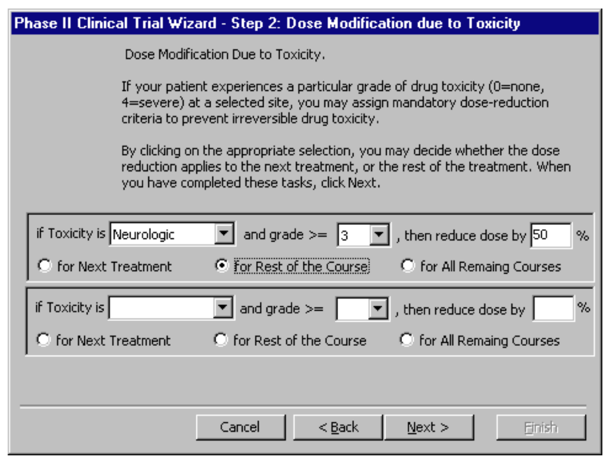
4.0 Design Studies

4.1 OncoTCAP

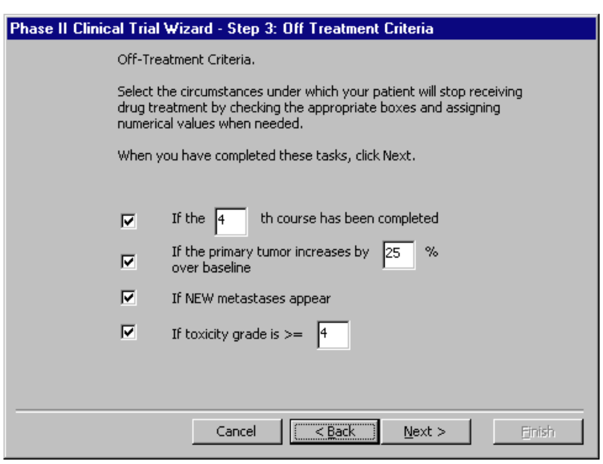
Designing clinical trials to test new drugs is a complex process that goes beyond controlling single variables. OncoTCAP is a simulation tool originally designed to help professional cancer researchers. To use this tool for helping medical students learn about clinical trials, the Phase 2 clinical trial wizard, shown in Figure 1, was developed (Hmelo et al., 2001). Scaffolding was developed based on expert scientists' experiment schemas (Baker & Dunbar, 1996). The simulation provides a context for learning as well as scaffolding to help learners deal with the complexity of clinical trial design.



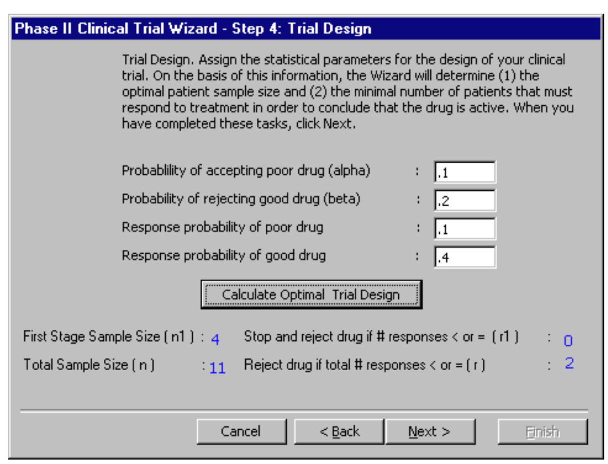
Step 1 of the Clinical Trial Design Wizard: Defining the dose and schedule



Step 2 of the Clinical Trial Design Wizard: Modifying the dose due to toxicity



Step 3 of the Clinical Trial Design Wizard: Deciding when individual patients will be taken off-treatment



Step 4 of the Clinical Trial Design Wizard: Setting the statistical parameters

Figure 1. Phase 2 clinical trial wizard (Hmelo-Silver et al., 2000)

OncoTCAP models populations of cancer cells and provides two ways of displaying simulation results. These representations allow learners to explore the simulation from the perspective of an individual patient or the population of patients. In the Cancer Patient Simulator (CPS), the interactive simulation of tumor cell growth is shown by means of a graph of the number, characteristics, and location of tumor cells in a single patient.

The Multiple Patient Simulator (MPS) runs the same simulation as the CPS over many patients. While the simulation is running, the MPS window shows a dynamic tally of the number of patients simulated, the number of responses, cures, and deaths. At the end of the simulation, the MPS window displays the history for any selected patient. The patient histories can be browsed, and a selected patient history can then be displayed in the CPS, showing the ordinarily invisible details of cancer cell subpopulations changing over time. The MPS and CPS are the main representations used for displaying Phase 2 Clinical Trial Wizard results.

The Phase 2 Clinical Trial Wizard helps scaffold student learning about trial design without dealing with the complexity of the underlying simulation environment. The screens were designed to help communicate the trial design process in terms of the Phase 2 clinical trial design schema. Design decisions were made based on (a) what experts need to know and (b) important aspects of the design process that novices have difficulty in understanding.

Breaking the task into multiple subtasks reduces the cognitive load required to complete the task. Thus, the scaffolding helps learners manage the complexity by focusing their attention on semantically important elements of the clinical trial design process. The wizard provides support for running the simulation in three ways. First, it makes the learner aware of the expected elements in the Phase 2 Clinical Trial by the contents of the various screens. Second, the wizard structures inquiry by allowing learners to concentrate on one subtask at a time. Third, much of the complexity of the simulation environment is reduced as the wizard uses a simplified interface to (a) transparently generate the input needed to run the simulation and (b) present only the relevant results to the learner.

Learning outcomes and processes were studied as groups of medical students worked with the OncoTCAP environment. The results demonstrated significant gains on a clinical trial design task (Hmelo et al., 2001; Hmelo-Silver, 2006). In addition, studies of the group discourse demonstrated the kinds of difficulties students had in understanding trial design, how the software helped in scaffolding the complexity, and where a human facilitator was needed to provide adaptive scaffolding (Hmelo, Nagarajan, & Day, 2000; Hmelo, Nagarajan, & Day, 2002).

4.2 RepTools

Complex systems are everywhere in the world, are difficult to understand, and are important for understanding in many science domains. The RepTools suite of tools was designed to support learning about complex systems by focusing on a conceptual representation, the structure-behavior-function representation (Goel et al., 1996). It consists of function-centered hypermedia and NetLogo computer simulations in two complex systems domains: the respiratory system and aquarium ecosystems (Liu, Hmelo-Silver, & Marathe, 2007; Wilensky & Reisman, 2006). These tools provide rich contexts and structure information based on expert models (Hmelo-Silver, Marathe, & Liu, in press). The hypermedia introduces the system with a focus on the functional aspects but provides linkages between the structural, behavioral and functional levels of the systems. By exploring this hypermedia, students can construct a basic understanding that prepares them for their inquiry with the simulations. For example, the function-oriented aquarium hypermedia introduces students to this system with two big functional and behavioral questions on the opening screen: “Why is it necessary to maintain a healthy aquarium?” and “Why do fish and other living things have different roles in the aquarium?” From these questions, the students can go to information about the functional aspects of the system, then to the behavioral aspects and finally to the structural knowledge (see Liu et al, 2006 for details).

The aquarium RepTools includes two NetLogo simulations that present aquarium models at different scales. The fish spawn model is a macrolevel simulation, simulating how fish spawn in a natural environment (Figure 2). The model helps students learn about the relationships among different aspects of an aquarium ecosystem, such as amount of food, filtration, water quality, reproduction, and population. The nitrogen cycle simulation presents a microlevel simulation of how chemicals reach a balance to maintain a healthy aquarium (Figure 3). This allows students to examine the bacterial-chemical interactions that are critical for maintaining a healthy aquarium. In both simulations, students can easily adjust variables such as fish, plants, and food and observe the effects of those changes. Multiple representations are available for students to examine the results of their inquiry. Students can observe the simulations, generate hypotheses, test them by running the simulation and modify their ideas based on observed results. The teacher needs to help scaffold group discussions to help learners make the connections between the macroscale model and the microscale model.

These tools have been used by in middle school classrooms (Liu et al., 2007). Preliminary data analyses indicate the promising effects of the RepTools in supporting deep learning about complex systems. The conceptual representations embedded in the curriculum affected what students learned particularly in those aspects of the system that are the hardest to learn and are critical for understanding science. The visualization and manipulative opportunities provided by the simulations afford students an opportunity to test and refine their ideas, which lead to deeper understanding. These results provided evidence about what students learned, but further analysis is needed to better understand how RepTools mediated learning and the kinds of scaffolding the teachers needed to provide.

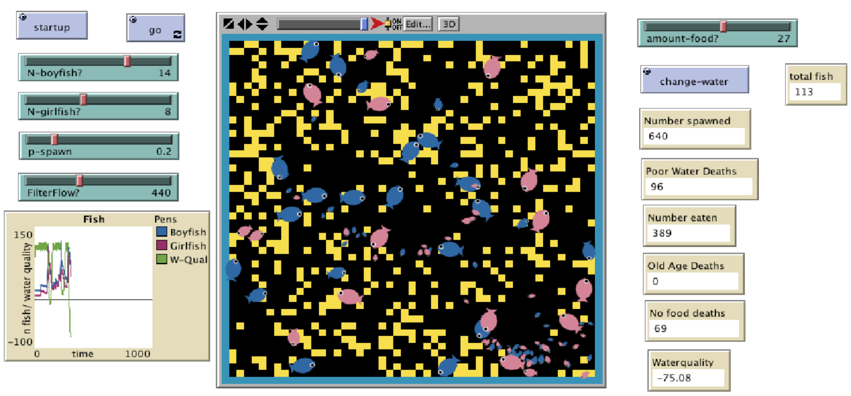


Figure 2 . Screenshot of the Fish Spawn Model.

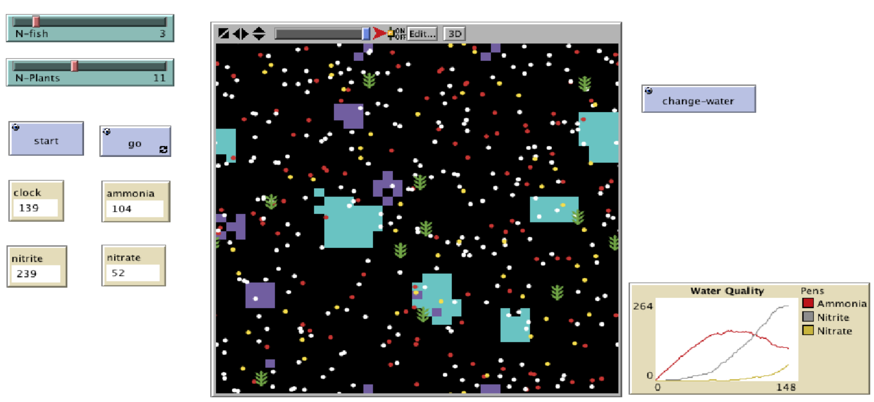


Figure 3. Screenshot of the Nitrogen Cycle Model.

4.3 STELLAR

STELLAR (Socio-technical Environment for Learning and Learning Activity Research) is an online environment for supporting problem-based learning (PBL; Derry, 2006; Derry et al., 2006; Hmelo-Silver et al., 2005). It was designed to help pre-service teachers understand how the learning sciences apply to classroom practice. This environment provides all four of the technology functions described: It provides a rich context, structures information, provides collaboration spaces, and scaffolds the complexity as learners engage in instructional planning. The STELLAR system contains a library of videocases that are linked to a learning sciences hypertext, the knowledge web (KW), and a pbl online activity structure. Video provides a context for collaborative lesson design. The example shown in Figure 4 shows video of a constructivist classroom that is linked to concepts in the KW. This is used for a PBL activity in which students design formative and summative assessments.

The KW is a cognitive flexibility hypertext that provides access to carefully structured information (Spiro, Feltovich, Jacobson, & Coulson, 1992). It was designed to help students bridge perceptual visions of teaching practice from the videocases with conceptual text materials from the learning sciences. The KW is designed to support forms of instruction that help learners create cognitive representations (schemas) that represent appropriate conceptual/perceptual meshing between these domains. The KW currently consists of interlinked web pages that contain explanations of important concepts, such as *metacognition or collaborative learning.* Every KW page contains links to other related concepts as well as to videocases that illustrate varied instances of learning science concepts at work in the classroom. This helps guide learners so that they create appropriate mental connections between learning science concepts and highly perceptual visions of practice.

Figure 4. Videocase linked to Knowledge Web

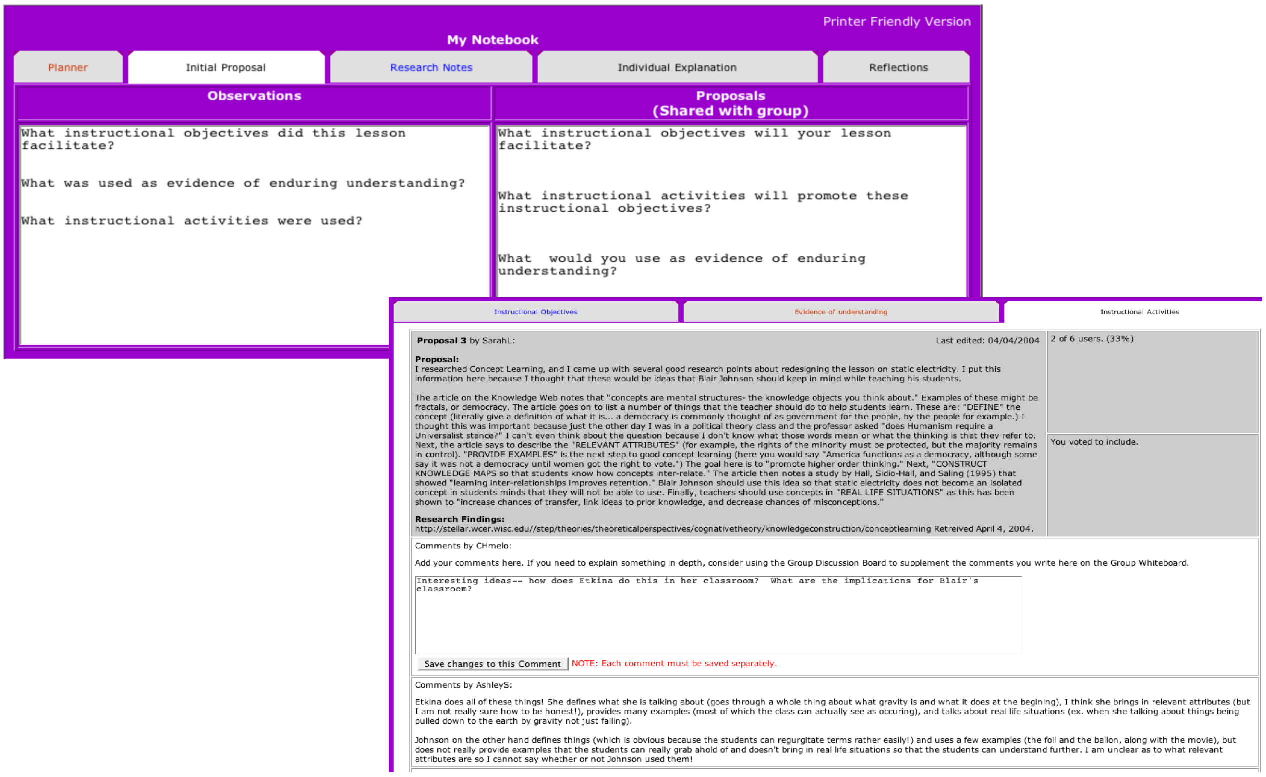


Figure 5. STELLAR personal notebook and group whiteboard

The pbl online module provides several tools that elicit articulation. Some of the tools presented in this environment include a personal notebook where students record their initial observations, a threaded discussion board, where students share their research and analysis of the video cases, and a white board where the students post their proposed solutions for the lesson redesign and can comment on each others proposals (Figure 5).

Students receive help to manage the complexity in several ways. First, by linking the video to the knowledge web, students receive suggestions for learning issues. Second, the activity structure helps offload some of the facilitation onto the system (Hmelo-Silver et al., 2005; Steinkuehler, Derry, Hmelo-Silver, & DelMarcelle, 2002). The STELLAR road map (Figure 6) helps remind the students of the different phases of the activity. The activity structure was modified from traditional PBL to help preservice teachers engage in instructional design and procedural facilitations were incorporated into the system to help students think about classroom instruction The activity was divided into a sequence that starts with individual problem analysis, moves on to group self-directed learning and lesson design, and ends with individual explanation and reflection. Students are asked to think specifically about objectives, assessments, and activities. This helps communicate a particular process of instructional planning. These same three categories are the focus of their problem solving and are used to label the online whiteboard. The online whiteboard and threaded discussion provide support for collaboration and anchor discussions in student's proposals for lesson design. Discussions occur asynchronously and allow students to be more reflective than in a synchronous discussion. Finally, individual notebooks provide opportunities for students to explain their group's design and reflect on their learning. The STELLAR sidewalk and the prompts in the individual notebook and group whiteboard provide scaffolds that communicate the PBL and instructional planning processes.

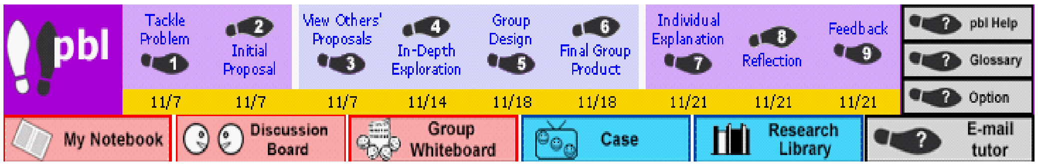


Figure 6. STELLAR sidewalk reminds students of activity structure

Over several semesters, students participating in STELLAR courses achieve more than students taking comparable courses (Derry et al., 2006). As part of a design research program, studies were also conducted of how students engaged with STELLAR, how they learned collaboratively, and what factors led to differential success in the system. How students use the system is a key factor in how they learn, and as with OncoTCAP, facilitation remains important (Chernobilsky, Nagarajan, & Hmelo-Silver, 2005; Hmelo-Silver, Chernobilsky, & Mastov, 2006). In effective groups, students often took on leadership roles that helped facilitate their group's learning and task completion (Hmelo-Silver, Katic, Nagarajan, & Chernobilsky, in press)

5 Conclusions

To solve real-world problems, people must be able to apply their knowledge in unpredictable ways, realize the limits of their understanding, work well with others, and have the lifelong learning skills to learn what they need to know. Constructing usable knowledge requires providing opportunities for learners to engage with complex phenomena, whether it is inquiry, PBL, or simulations. Technology provides opportunities to create these rich contexts as the examples from OncoTCAP, RepTools, and STELLAR demonstrated. These provided students with many opportunities to observe phenomena and reason about them from different perspectives thus expanding their understanding. By re-viewing video and re-running simulations, learners had many opportunities to deal with complex phenomena. But providing context alone may not be sufficient. Learners need access to information structured to promote deep understanding and transfer. In the RepTools environment, information was organized based on an expert model. STELLAR structured the connections between videocases and learning sciences concepts to promote construction of meshed schema representations. The contexts for these hypermedia helps students realize the limits of their understanding so they learn how knowledge can be applied to complex problems.

Learners could easily struggle in these contexts or not realize the interconnections among contexts and information thus scaffolding student inquiry and self-directed directed learning is critical. The Phase 2 clinical trial wizard models an appropriate experiment schema and calls attention to aspects that students have difficulty with. STELLAR helps bootstrap student's self-directed learning skills through links between the videocases and KW. Students are scaffolded in instructional planning through tabs in the whiteboard that communicate the lesson design process and promote articulation and discussion of their evolving ideas.

Complex learning requires integrated development of knowledge, inquiry practices, reasoning strategies, and lifelong learning skills in a variety of situations. Such learning is hard because complex domains often span a range of subject matter and skills and poses great challenges to cognitive, metacognitive, and social resources. Technology has great power to afford complex learning experiences that would not otherwise be possible as well as providing tools that can help deal with these challenges.

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Can we support CSCL?
Educational, Social and Technological Affordances for Enjoyable Learning

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Behold. A doorknob!

You look at this object and probably conclude that it should be grasped and turned, and either pulled or pushed. A cognitive psychologist would say that you know this thanks to pattern matching and scripts. Pat-tern matching entails having schemas of all different types of objects somewhere in your brain and match-ing what you see with what you 'know'. You determine that it is not only a doorknob, but also a doorknob of a certain type namely one that also contains a lock. Having successfully done the matching, you then search for a script stored somewhere in your memory which tells you that for this specific doorknob you use the specific script: grab and turn. A similar object initiates similar processes.

Ecological psychologists look at this differently. They see the object itself as having certain properties, which 'tell' you what to do. In other words, there is a relationship between an actor (you) and the world (the knob). In this way of thinking, this door knob has grab and turn properties on a door with either push or pull properties for an actor with an opposable thumb (to grab; hominoids), a flexible wrist (to turn; an arthritis sufferer doesn't have this) and sufficient mass (to pull or push).

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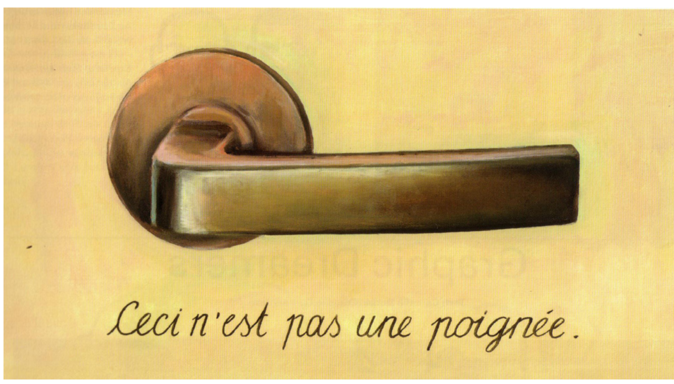
But is this the same here above? These characteristics of an object are known as affordances and properly exploiting them is - in essence - taking care that these affordances are perceived and used. Thus:



What's it all about?

At the time of this writing, the communal opinion in education land appears to be that collaborative learn-ing is the golden key to the future. Computer supported collaborative learning (CSCL) environments are seen as tools that permit educators to latch on to current constructivist insights in teaching and learning that rely heavily on collaborative learning, encompassing dialogue and social interaction amongst the group members and that allow learners and instructors to be geographically dispersed, thus relaxing the need to be co-located for meetings and discussions. In addition, learners can often engage in learning at any time, dis-missing necessity for co-presence. This 'anywhere-anytime' characteristic enables a shift from real-time contiguous learning groups to asynchronous distributed learning groups, something especially interesting for distance learning institutions.

Despite this potential, research on the use and effectiveness of CSCL environments is inconclusive. Re-searchers, educators and designers have reported positive (Brandon & Hollingshead, 1999) and negative outcomes. The negative outcomes are predominantly based on low participation rates and/or varying de-grees of disappointing collaboration. For example, Hallett and Cummings (1997) observed: "By having the majority of assignments in public forums with the entire class posting at a given time, and with numerous prompts and encouragement from the instructor, it was hoped that interaction among students would occur naturally. This was not what took place" (p. 105). Fischer, Bruhn, Gräsel, and Mandl (2002) report that "an array of studies … has shown that efficient learning rarely is achieved solely by bringing learners together" (p. 216). Generally, low learning performances in terms of quality of learning and learner satisfaction in CSCL environments are the consequences.

Gunawardena (1995) explains the negative experiences from her observations in computer conferences where “the social interactions tend to be unusually complex because of the necessity to mediate group ac-tivity in a text based environment. Failures tend to occur at the social level far more than they do at the technical level” (p. 148). Hobaugh (1997) emphasizes that in distributed group learning, problems with so-cial dynamics amongst group members are often the major cause of ineffective group actions. In other words, all the more reason to take a closer look at the social and social psychological aspects of collabora-tive learning in (a)synchronous distributed groups and how they can be supported.

The subject of this contribution is the conditions under which computer supported collaborative learning can lead to knowledge sharing and knowledge building. It deals with this from two sides that are connected to each other by the word AFFORDANCES.

Affordances

Let’s go back to the door knob. Short and sweet, affordances are the perceived properties of a thing in refer-ence to a user that influences how it is used. Some door handles look like they should be pulled. Their shape leads our brains to believe that is the best way to use them. Other handles look like they should be pushed, a feature often indicated by a bar spanning the width of the door or even a flat plate on the side.

Originally proposed by Gibson in 1977 (and refined in 1979), the term affordance refers to the relationship between an object’s physical properties (artifacts) and the characteristics of an agent (user) that enables par-ticular interactions between agent and object. He stated that “the affordance of anything is a specific combi-nation of the properties of its substance and its surfaces with reference to an animal” (Gibson, 1977, p. 67). A pond, due to the surface tension of the water, affords a surface to walk on for certain species of flies while also affording a living environment for certain types of fish. Knobs are for turning and slots are for inserting things. These properties/artifacts interact with potential users and provide strong clues as to their operation (think of your child, his/her peanut butter sandwich and the slot in your video recorder!). Norman (1988, 1990) and Gaver (1991, 1996) appropriated the term as a conceptual tool for discussing the design of interactive systems and respectively speak of perceived and perceptible affordances.

According to Gibson, the perceiving organism and the environment are intimately related. The environment does not provide ‘objective’ information equal for everyone, but rather different opportunities depending upon the actors and their needs. Affordances are - in Gibson’s view - resources which are revealed to those who seek them. A tree in the middle of a field on a summer’s day is only an affordance to those who seek its cool shade. An affordance, thus, is the link between perception and action (perception-action coupling) in which the performance of an action is based on the “fit” between the physical capabilities of the actor and the constraints imposed by the environment. A second characteristic of an affordance is what is known as the reciprocal relationship between the organism and the artifact. We can sit on a chair because our knees bend in a certain direction. A circus elephant’s knees bend in the same way and thus she can sit on a barrel. But the knees of a giraffe bend in the opposite direction and thus this animal cannot perform the same action.

For complicated artifacts such as educational environments, learning must also be considered and is permit-ted. There is a perception-action coupling, but it is less direct. After a learning/habituation period, the ac-tions become automatic and unconscious. Affordances in this sense don’t cause, but merely allow. They lower the threshold for carrying out and/or permit an action.

Four premises

Premise 1 It is not only the properties of a medium that affect how they can be/are used, but also how (and if) they are perceived and the relationships that exist between the properties and the use(r).

Examples:

• In an office hallway, vertical, see-through glass windows next to the door allow you to see if the light is on (indicating possible presence), if the occupant is actually present, if the person is busy working, and thus whether it is opportune to enter the room.

• Email allows CSCL-users to communicate. But not all email is the same. Email via broadband to individual computers makes continuous connection, quick response, and sending and receiving large attach-ments possible. Email via modem to a central computer necessitates sporadic use, slow response, and small attachments the order of the day.

Both examples show the technological affordances present in the objects (hall/email), but there is more. The fact that the windows need to be at least translucent, that the height and placement of the windows must allow looking through them and that good manners dictate that we don't interrupt someone talking to an-other person also determine whether certain behaviors can be/are afforded. Broadband connection allows us to use email in an instantaneous way and informs us that an immediate response means that the addressee is probably at his/her desk moment.

Although every object has specific affordances, what we as educational researchers and designers are actu-ally dealing with are not the affordances themselves, but rather the combination of the perceptible (Gaver, 1966) or perceived (Norman, 1990, 1999) affordances, the constraints that are placed upon them, and the conventions regarding the affordance and its use.

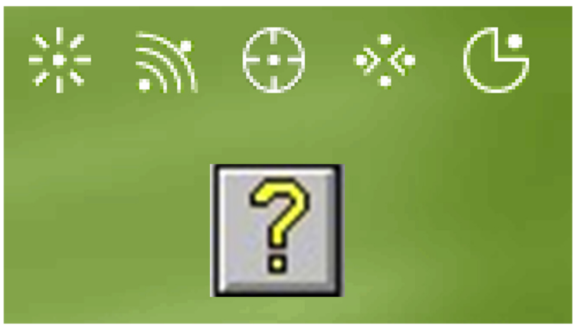
What we see on a computer screen is not the affordance, but rather the visual feedback advertising the af-fordance – *the perceived affordance*. When affordances are perceived, a link between the perception and an action can result; the perception-action coupling. These perceived affordances are limited by physical (you can't see through opaque glass), logical (you don't put a window on the bottom of a door), and cultural (you don't put a window in a toilet door) constraints and cultural conventions (you don't interrupt a conversa-tion). With respect to the use of computers we see the following:

• *Physical constraints* are closely related to affordances in the pure Gibsonian sense. Physical limitations constrain possible operations. A square peg cannot fit into a round hole and a cursor cannot be moved outside of a screen.

• *Logical constraints* use reasoning to determine the alternatives, thus, if we ask a user to click on five locations and only four are immediately visible then the (experienced) user knows, logically, that there is still one location left, but that it must be somewhere not visible at that moment and will look and see if there is a scroll-bar on the right side of the screen and scroll down to see the alternative that was not originally visible.

• *Cultural constraints* are learned conventions shared by a group. Designing a button for display on a monitor and saying that it 'affords clicking' is wrong. Without a mouse or a touch screen clicking doesn't exist, and with a mouse or touch screen the user can click on any pixel on the screen! The but-ton provides a target, helps the user know where to click, and probably even cues what the user can ex-pect if (s)he clicks on it, but in the words of Norman "… those aren't affordances, those are conven-tions, and feedback …" (Norman, 1999, p. 40). In other words, the designer has introduced a cultural convention that has been learnt and reinforced through feedback, namely that an object on a screen that looks a certain way will also act in a certain way, and lead to a certain outcome. An example of such a convention is the earlier mentioned scroll bar on the (right) side or bottom of a screen which tells us that there is more text below or to the right and that by clicking in the area and 'dragging it down or to the right, the text will scroll up or to the left! This is known as the 'outside-in' convention. Software programs in the Adobe® suite use the 'inside-out' convention, namely that the text moves in the direction that the cursor is moved, but to differentiate this they used a hand to symbolize grabbing the text. Such conventions prohibit some activities while encouraging others.

Conventions - according to Norman - are arbitrary yet stable and violating them often leads to conceptual and usage problems. That a question mark signifies a ‘help function’ on a web-page is arbitrary; it could have just as easily been a different icon. An example of violating this convention is well known to Open University of the Netherlands staff and students. The symbol set on its web site violates conventions with respect to the search- and help functions and makes usage for those who are not in ‘the in crowd’ unclear and difficult. Which of the following is the help function?

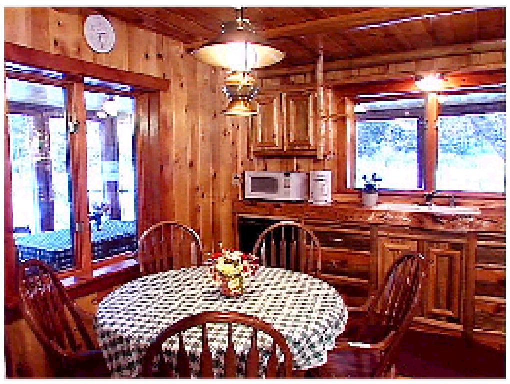


Premise 2
Behavior is embedded in and shaped by its cultural and material context.

Hofstede (1997) noted that distinct cultural diversity can exist between nearby national cultures. One does not have to look very far to see this. Within Europe, there are enormous cultural differences between the sober and no-nonsense German, the staid Brit and the Bourgondian, life loving French. These differences manifest themselves in social behaviors which influence relationships, habits, and beliefs. In other words, social behavior is embedded in a group’s particular cultural context and is guided by deeply held values and beliefs. Ignoring or abusing these differences can bring about social failures and cause otherwise good things to go wrong (Hoecklin, 1994).

In education, and especially in distributed learning groups, Hofstede’s (1980) ideas on factors determining diversity take on special importance. He describes four dimensions by which (national) cultures vary, namely power distance, uncertainty avoidance, collectivism-individualism, and masculinity-femininity . In distributed learning, Granger (1995) points out that Hofstede’s ideas on diversity influence factors as knowledge, prior skills, (implicit) language, learning patterns and styles, and learning goals and motiva-tions.

But behavior is not only embedded in and shaped by cultural context; it is also embedded in and shaped by material context. Take the following two dining areas.



Both tables, except for their size (and thus the number of places) afford the exact same things. The differ-ence is that the top figure depicts a table in an elegant dining room for a formal meal while the lower de-picts a table in a cozy dining room for a 'family dinner'. The way we behave at the top table will probably be quite different from the way we behave at the bottom one. The affordances are the same, but the material contexts are different and so are the social behaviors that will be exhibited. This is also true for the earlier described email contexts.

Examples:

• Discussions in a meeting context are quite formal and regulated. Participants are formally invited to at-tend which begin and end at a certain time and follow a set structure. There are often roles (both explicit and implicit) for the different participants and there are many spoken and unspoken rules of decorum.

Discussions in a party context are informal and occur between people in close physical proximity. The structure changes quite often (as do the subjects discussed) without any fixed, predetermined order. The roles of the participants also change quickly depending upon who enters the discussion at any moment. Finally, although there are also rules of decorum at a party, they are quite different from those at a formal meeting.

• Face-to-face collaboration is dominated by social presence (a sense of being together) where individuals can effortlessly interact. They not only work on a task, but also sense each other (smell, see, touch), share non-task activities (eat, drink, small talk) and manage their and each other's attention - activities all crucial for sustaining the social relationships that make distributed work possible.

Distributed collaboration supported by computer mediated communication (CMC) systems is weak in so-cial presence. The user feels alone most of the time (a sense of isolation), often not knowing who else is busy at any given time. Users work on their own task, sometimes on a previous concept of a solution or partial solution proposed by another though not knowing if someone else is doing the same thing at the same time. There is no - or a limited - sense of one another and almost all interaction is 'on-task'. Room for social interaction is limited. Instant messengers, avatars, web-cams, microphones, and software programs for synchronous meetings all try to increase social presence.

The technological context also influences behavior. Gaver (1996) eloquently argues that 'new technologies seldom simply support old working practices with additional efficiency or flexibility. Instead they tend to undermine existing practices and to demand new ones . In this disruption, subtleties of existing social be-haviors and the affordances upon which they rely become apparent, as do the new affordances for social behavior offered by technology' (p. 112). This suggests that the process of technology design and imple-mentation requires careful attention to established practices within the target community.

Premise 3
The context of CSCL is a unique combination of the technological, social, and educational context.

If we look at this statement carefully, we see that it is true of all learning. Learning is - by definition - con-textual. Not since the demise of behaviorist learning theories have we thought that we can learn isolated facts and theories which are, in some abstract way, divorced from the rest of our lives. And with the rise of constructivist thought about learning it is accepted that we learn in relation to how we encounter something, where we encounter it, with whom we encounter it, in relation to what else we know and what we believe (Kirschner, 2000; Kirschner, van Merriënboer, Carr, & Sloep, 2002).

Take, for example, the two preceding figures. Both represent learning situations, but the contexts in the two are completely different along all three dimensions. The educational contexts are different (competitive versus collaborative), the social contexts are different (individual versus group), and the technological (physical) contexts are different (individual workspaces with minimal assortment of materials versus group workspace with a rich assortment of materials).

CSCL in its usual form represents yet another learning situation. The educational context is one of collabo-rative learning, the social context is the group, and the technological context is computer mediated. At many institutions, CSCL is synonymous with a computer mediated communication environment where the lowest common user denominator determines the design choices made. The educational context is often competence-based grounded in social constructivism. The social context is one of minimal direct contact and primarily asynchronous, text based contact (email, discussion lists, and commercially available elec-tronic learning environments) between students.

Premise 4
When technology mediates the social and educational contexts we speak of 'technology affording learning and education'.

This means that the present conceptual framework of technological and social affordances needs to be en-riched with the concept *educational affordances.*

Bradner, Kellogg, and Erickson (1999) define a *social affordance* as "the relationship between the proper-ties of an object and the social characteristics of a group that enable particular kinds of interaction among members of that group" (p. 153). The physical world is a rich and very social space. Although a hallway in an office complex affords little interaction (except for people passing in them), if the doors are open or if the area next to the door is fitted with glass, then the hallway now affords more awareness of and contact between employees. A step further is the coffee lounge or water cooler. They allow inhabitants to meet, become aware of each other and casually converse. Dieberger (2000) considers awareness of other people's activities to be an essential ingredient for collaborative work. An overheard conversation and the awareness of what other people are working on can trigger chance conversations in hallways or informal talk that often prove more important for a project then the meeting itself. Mulder, Swaak, and Kessels (2002) confirm the value of such social, non task-related activity noting a marked increase in task/domain related work following sessions in which there was a high degree of social activity between group members.

In the 'physical' world, affordances abound for casual and inadvertent interactions. In the 'virtual' world, social affordances must be planned and must encompass two relationships. As stated earlier, there must be a *reciprocal relationship* between group-members and the CSCL environment. The environment must fulfill the social intentions of members as soon as these intentions crop up while the social affordances must be meaningful and support or anticipate those social intentions. Second, there must be a *perception-action coupling*. Once a group-member becomes salient (perception), the social affordances will not only invite, but will also guide another member to initiate a communication episode (action) with the salient member. Salience depends upon factors such as expectations, focus of attention, and/or current context of the fellow member.

Educational or learning affordances are those characteristics of an artifact (e.g., how a chosen educational paradigm is implemented) that determine if and how a particular learning behavior could possibly be en-acted within a given context (e.g., project team, distributed learning community). Educational affordances can be defined - analogous to social affordances - as the relationships between the properties of an educa-tional intervention and the characteristics of the learner (for CSCL: learner and learning group) that enable particular kinds of learning by him/her (for CSCL: members of the group too).

Educational affordances in distributed learning groups encompass the same two relationships as social af-fordances. The CSCL environment must fulfill the learning intentions of the member as soon as these inten-tions crop up while the affordances must be meaningful and must support or anticipate the learning inten-tions of the group-member. Further, once a learning need becomes salient (perception), the educational af-fordances will not only invite but will also guide her/him to make use of a learning intervention to satisfy that need (action). The salience of the learning intervention may depend upon factors such as expectations, prior experiences, and/or focus of attention.

And what if these affordances are not properly exploited? Take the case of many doors which, for some reason, have pull handles on both sides, but can only be pulled in one direction. An unsuspecting person is likely to waste half a second or more, over and over again, pushing doors that should be pulled, and pulling doors that should be pushed. We've all done it, and we've all been frustrated by that simple, glaring over-sight. And if you think that such an incident will only happen once, think again: We push and pull doors all day, and pay less attention to our surroundings when doing so. In other words, we forget which doors should be pushed and pulled, and act based on the indications we're given, even if they are misleading. And when we do it wrong, we get slightly annoyed but go upon our way. Now consider how CSCL group mem-bers feel after they've worked long and hard on an educational problem, only to see after posting their work that someone else has also posted something either duplicating their work or going in a completely different direction. We are not talking about wasting of split seconds nor continuous, small inconvenience in a situa-tion that we cannot avoid (no one will chose not to enter a building because of poorly afforded doors), but rather of wasting large amounts of precious study time and large inconveniences in a situation that the learner CAN (and often does) quit.

(Non)affordances in CSCL environments

The Babble environment (Bradner, Kellogg, and Erickson, 1999) allows users to watch for whether other persons are active and allows the opening of a communication channel with them. This is known as waylay. Here, a participant in a group is alerted that another group member has logged on and is active. Knowing this, synchronous communication can be initiated. ICQ® and MSM Messenger® are examples of function-alities or widgets that also make this possible.

Since the possibility to communicate in Babble exists, we might also conclude it would be used. Unfortu-nately, this was not always the case. That waylay was possible did not mean that it was welcomed, that it resulted in helpful interactions, nor that it was viable over the long term. Some remote users feared that others could and would use the affordance to delegate work to them and avoided using the environment. Although Babble supported waylay, it was not socially afforded - here because of the social characteristics of the group. What was missing were group characteristics such as strong social ties, generalized reciproc-ity, and shared understanding of the limits of what may be asked in a waylay. The social affordances needed in such a situation are:

• *Shared understanding: t*he state where two or more people have equivalent expectations about a situation, i.e., their explanations of the situation and their predictions for how it might develop are the same. A lack of shared understanding often leads to *coordination breakdowns* (mismatch be-tween expectations of one participant and actions of another) or *conflict* (the perception of opposing goals, aims, and values).

• *Accountability:* the social mechanism underlying responsible behavior; e.g., not plagiarizing a fellow team member, not working for the disadvantage of a fellow team member.

• *Trust:* the deciding factor in a social process that results in a decision by an individual to accept or reject a risk based on the expectation that another party will meet the performance requirements (Zolin, Fruchter, & Levitt, 2000).

• *Social cohesion:* the tendency of group members to stick together (Sproull & Kiesler, 1991) and the sum of all forces which act on individuals to stay in a group (Festinger, 1968). Simply stated: the tendency of group members to like and trust one another.

• *Predictability:* the quality of a situation that allows those in that situation to foretell that - on the ba-sis of observation, experience, or scientific reason - an expected outcome will turn out to be the ac-tual outcome.

Noteworthy in this respect is the 'awareness paradox' documented by Reffell and Eklund (2002), namely the finding that students appreciate being invisible while online so that others cannot contact them while at the same time wanting extra awareness features to let peers know exactly what they are doing.

Veldhuis-Diermanse (2002) concluded in her recent dissertation that although ICT-literate university stu-dents were given the opportunity to construct knowledge in a CSCL environment they did not make optimal use of this possibility. Although knowledge construction was relevant for the successful completion of the course, the system did not stimulate the students to construct knowledge – the primary goal. What she found was that the students used the system primarily to exchange information. At the end of her disserta-tion she presents 29 interventions or "conditions suggested to increase the use of CSCL in university courses". Some are typical educational techniques that should always be part of good education such as: formulate unambiguous learning goals, take care that the students need to follow the course, or organize the course well. Other conditions are specific for CSCL such as: organize regular face-to-face sessions, use a transparent and user-friendly CSCL-system, consider moderating discussions, and give students the time to learn to use the system and understand the task. What she actually is saying – in my opinion - is that the tool didn't work and that it needs a lot of 'enhancements' to allow it to work.

The question is: Why do users of CSCL environments tend to accept such imperfections from those envi-ronments when they would not accept them from other tools that they use? A different way of saying this is: Did the situation – the combination of the educational, social and technological contexts afford the desired learning?

The key is interaction

We need to dissect the concept 'computer-supported collaborative learning' to determine what a CSCL-environment should entail. First of all we are talking about learning, and in the twenty-first century we are usually talking about constructivist learning (Kirschner, 2000). The proximate modifier (adverb) is the word collaborative. To collaborate is to work jointly with others especially in an intellectual endeavor. Thus, the work that is to be carried out is learning, and the way that it is done is together with others. Finally, the ul-timate modifier is computer-supported (a compound adverb). That the computer supports something means that the computer (and some network) enables something to occur and/or that the computer keeps some-thing going. The 'thing' that the computer supports is collaborative learning.

This collaboration requires different modes, types, and degrees of interaction. The potential for interaction in a learning group/community arises, as we have seen, from the properties of the (1) technology (or me-dium) being used to mediate the interaction, (2) group(s) engaging in the interaction, and (3) learning situa-tion. These three properties concur with Kuutti and Bannon's (1993) three perspectives on human computer interaction: the technological level, the work process level, and the conceptual level.

This leads then to the primary research question for CSCL, namely:

How can CSCL be optimized by proper usage of technological, educational and social affordances?

This leads to the following two research thrusts:

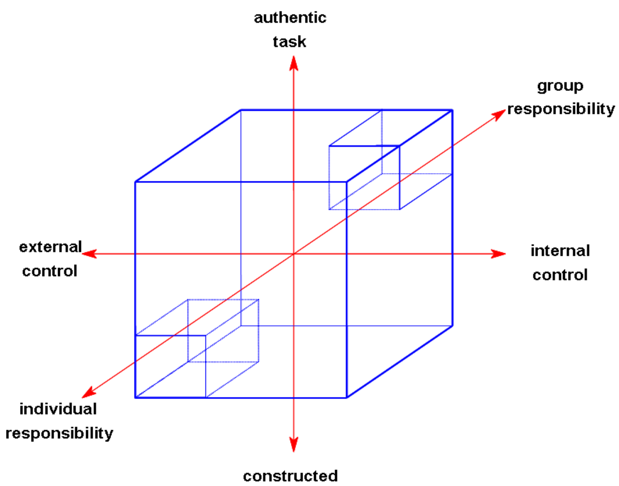
Analyze the combination of educational, social, and technological affordances for collaborative learning.

Design CSCL (environments) and tools for optimizing (the perception of) affordances for learning.

Three factors influencing educational affordances

Most CSCL research focuses on surface characteristics of the environment, the collaboration or the learning paradigm such as the (a)synchronicity of an environment, optimal group size or whether the task was a problem or a project. This surface level approach disavows fundamental questions about the environments such as: Was ICT necessary? Did learners design or prove something? Was the goal divergent and creative (design) or convergent and specific (diagnose)? Who determined the goal, how to reach it and what is cor-rect? Was the evaluation competitive or collaborative? are swept under the rug. This surface level approach is analogous to comparative media studies in education. In his landmark review, Clark (1983) argues that researchers focus on the media used and the surface characteristics of the education they provide. As a con-sequence, comparative research tends to be inconclusive and the learning materials developed tend to be unpredictable at best and mathemathantic at worst.

In the following sections, I will provide a framework for optimizing the educational affordances of CSCL-environments and with this set the research agenda on CSCL. The framework is composed of three non-surface level factors central to the design of any environment: task ownership, task character and task con-trol.



Task ownership

Task ownership (the X-axis of the figure) is basically a question of who determines or is responsible for determining what each of the participants in a collaborative learning environment must do and who pro-vides the (social) steering?

In traditional education the institution is the owner. At the macro level this is often the government that not only legislates what needs to be learnt, but also very often determines how it should be tested. At the meso level it is the school that does this. The school chooses learning methods and materials, organizes where and how it will be taught and how it will be tested. Finally, at the micro level it is the teacher who deter-mines everything. This 'didactic' approach which emphasizes individual acquisition of knowledge and skills has worked for years, it has been handed down from generation to generation and is very difficult to change.

This approach is also visible in many CSCL- environments which emphasize the knowledge and skills that each group member individually must attain (Johnson, Johnson, & Johnson-Holubec, 1992; Slavin, 1997). One could convincingly argue that such implementation is paradoxical, contradictory and counter-productive. This paradox is exacerbated by their use of competitive assessment methods (Kirschner, 2000).

At the other end of the continuum are competency-based environments where not the individual acquisition and application of knowledge and skills is most important, but rather the performance of each individual in and with the rest of the group. Environments that stress and reward individual initiative, that are open to influences from the students and where the students themselves are owners of the learning problem are found here.

The need for a feeling of ownership is based upon two pedagogical principles considered to be highly bene-ficial to learning/working in teams, namely individual accountability and positive interdependence.

Individual accountability (Slavin, 1980), as concept, was introduced to counter a number of deleterious effects of working together in groups. The free-rider or hitchhiking effect exists when group members exert less effort as the perceived dispensability of their efforts for the group success increases (Kerr & Bruun, 1983). In other words, they feel that the group is doing enough and that they don't have to contribute. *So-cial loafing* (Latané, Williams, & Harkins, 1979) exists when group members exert less effort as the per-ceived salience of their efforts for the group success decreases. In other words, as the group size increases so does the anonymity and the non-participation. The social loafer differs from the free rider in that the first lacks the motivation to add to the group performance, while the last tries to profit from others while mini-mizing essential contributions. Finally, the *sucker effect* (Kerr, 1983) exists when the more productive group members exert less effort as the awareness of co-members free-riding increases Those group-members refuse to further support noncontributing members (they refuse to be 'suckers') and therefore re-duce their individual efforts.

Individual accountability not only conceptually helps counteract the inability to control and assess individ-ual learning and contribution, but also allows the institution to operationally counteract it. By allowing for and even stressing individual accountability, what the group does as a whole doesn't become less important, but the individual contribution becomes more important. It is perfectly valid that in a group environment, each group member be held individually accountable for his or her own work. For example, in many prob-lem based learning environments students' sense of individual ownership is increased by also grading them for their individual effort, irrespective of the group's performance.

Positive interdependence (Johnson, 1981) reflects the level to which group members are dependent upon each other for effective group performance (enhanced intra-group interaction). The concept holds that each individual can be held individually responsible for the work of the group and that the group as a whole is responsible for the learning of each of the individual group members. Team members are linked to each other in such a way that each team member cannot succeed unless the others succeed; each member's work benefits the others (and vice versa). Essential here is social cohesion and a heightened sense of 'belonging' to a group . Positive interdependence is evident when group members in a project-centered learning envi-ronment carry out different tasks within a group project, all of which are needed in the final product. This interdependence can be stimulated through the task, resources, goals, rewards, roles or the environment itself (Brush, 1998). In other words, individual accountability and positive interdependence counter the ten-dency towards hiding and anonymity. In situations requiring such interdependence, students learn more than when this is not the case (Lou, Abrami, & d'Apollonia, 2001).

In collaborative environments, educators often make use of specific techniques that structure a task specific learning activity. Examples of such techniques are Student Teams-Achievement Divisions (Slavin, 1986), Jigsaw (Aronson, Blaney, Stephan, Silkes, & Snapp, 1978; Slavin, 1990) and Structured Academic Contro-versy (Johnson & Johnson, 1993) .

Finally, the perception of ownership tends to (intrinsically) motivate students to carry out a task/do an activ-ity because they want to not because they have to (e.g., Self determination theory ; Deci & Ryan, 1985; Ryan & Deci, 2000).

Task character

Constructivism holds that knowing is an active, adaptive process involving the person learning and the con-text in which (s)he learns (Brown, Collins, & Duguid, 1989). Learners assimilate new concepts into already available cognitive structures (schemas - ultimately the result of prior experiences and prior learning) and the schemas are in turn adapted to accommodate new interpretations of experiences (von Glasersfeld, 1988). Knowing and doing cannot be separated and as such, the character of a task (the 'doing' component) is of the utmost importance for learning (the 'knowing' component) regardless of whether learning is col-laborative.

Task character (the Y-axis of the figure) deals with questions as: How can we determine whether a task is relevant for the learner(s)? and Who determines whether the task in a collaborative learning environment is relevant? The character of a task can be depicted along a continuum running from constructed, well-defined, convergent tasks to authentic, ill-defined (wicked), divergent tasks.

Traditional school tasks are highly constructed, well-structured, well-defined, short, oriented towards the individual, and designed to best fit the content to be taught instead of reality. Archetypal problems of the type are, for example: "Two trains traveling in opposite directions at a speed of … How long …". Such tasks, though often seen as highly suitable for acquiring individual skills, are neither representative for the type of problems that are perceived of as relevant by the student nor proven to be especially effective for achieving transfer or for acquiring complex skills and competencies. This is the case for both group and individual learning. In small group learning, Cohen (1994) found that groups were not productive when tasks were closed with only one fixed answer, but were productive when tasks were open to multiple per-spectives and solutions. With respect to individual learning Spiro, Coulson, Feltovich, & Anderson (1988) found that the solutions to typical school problems tend to be too obvious for students, so that many stu-dents could not solve 'real life' problems involving sets of more real life, complex factors. They conclude that many learning failures, including the inability to transfer knowledge and apply it to new cases, result from just this cognitive oversimplification. Also, since the way learners interpret and make use of situations is influenced by their prior experiences (Akhras & Self, 1996), such tasks - inextricably linked to prior ex-periences in constructed, often tedious school situations - have almost no relationship to their own real-world experiences and are thus experienced as non-authentic, boring, and often trivial.

At the other end of the spectrum are 'real life' (authentic) problems that are almost always ill-structured (Mitroff, Mason, & Bonoma, 1976) and/or wicked (Rittel & Weber, 1984; Conklin & Weil, 1997). They are often so complex and multifaceted that they can only be adequately solved by multidisciplinary groups, where group members assuage cognitive conflict, elaborate on each others' contributions and co-construct shared representations and meaning.

A complicating factor here, however, is that authenticity itself is variable; it is not always clear to whom and to what extent an authentic task really is 'authentic'. Is a task authentic when students have to play a role with which they have no affinity or if they are not familiar with the actual practice such as when a freshman has to play the role of bank manager? Is the problem that needs to be solved really 'our' problem or more 'yours, hers or theirs'? And so forth.

Whatever the case, such problems require a different educational approach than do simple, well-defined ones. Learning to solve problems involves acquiring complex cognitive skills and competencies, which in turn requires making use of meaningful whole tasks (Van Merriënboer, 1997), since real life tasks are, after all, never come in neatly constructed segments of some idealized whole. These tasks, however, then need to be divided into non-trivial, authentic part-tasks because the full complexity of real-life tasks typically inter-feres with such effort-demanding inductive processing (Nadolski, Kirschner, van Merriënboer, & Hummel, 2001). In a collaborative situation these part-tasks often aim at achieving epistemic fluency: "the ability to identify and use different ways of knowing, to understand their different forms of expression and evalua-tion, and to take the perspective of others who are operating within a different epistemic framework" (Mor-rison & Collins, 1996, p.109). Ohlsson (1996) enumerates seven epistemic tasks that can be used in the de-sign of collaborative environments. They indicate the 'discourse-bound' activities that learners will have to fulfill during collaborative learning.

Table 1. Epistemic tasks (Ohlsson, 1996, p. 51)

Epistemic task	Meaning
Describe	Fashion a discourse referring to an object or event such that a person in that discourse acquires an accurate conception of that object or event
Explain	Fashion a discourse such that a person in that discourse understands why that event happened
Predict	Fashion a discourse such that a person in that discourse becomes convinced that such and such an event will happen
Argue	State reasons for (or against) a particular position on some issue thereby increasing (or decreas-ing) the recipient's confidence that the position is right.
Critique (evaluate)	Fashion a discourse such that a person in that discourse becomes aware of the good and bad points of that product
Explicate	Fashion a discourse such that a person in that discourse acquires a clearer understanding of its meaning
Defining	Define a term is to propose a usage for that term

These types of tasks (task classes) are archetypical for competence based learning for achieving what Honebein (1996) calls the "pedagogical goals" of constructivist learning environments, namely knowledge construction, appreciation of multiple perspectives, relevant contexts, ownership of the learning process, social experience, use of multiple representations, and self-consciousness/reflection.

Task control

Task control (the Z-axis of the figure) relates to the shift of control from educational institution or system (often personified by the teacher) to learner with respect to the path, events and/or flow of instruction and learning. This final continuum runs from complete institutional control of what, when and how things are taught to complete learner control where learners actively define and negotiate learning tasks (the heart of constructivist learning). Although the idea of this shift of control can be traced back to Dewey, it came to maturity in the last quarter of the twentieth century with psychology's flirtation with aptitude-treatment-interactions (ATI: Cronbach & Snow, 1981) and the emergence of instructional design theories. From the ATI side, learner controlled instruction is seen as instructional events or tactics that increase learner in-volvement, mental investment, and achievement. Learners are free to choose learning activities that suit their own individual preferences and needs. They tailor their instruction to their own style of learning, leading to more efficient and effective learning and higher motivation. On the instructional design side, Merrill (1983), for example, prescribes learner control of content (encompassing curriculum, lesson, and module selection) and of strategy (spanning various forms of presentation). He (1987) contends that when this is the case, learners themselves arrive at self-determined instructional strategies which are optimal, when given an opportunity to exercise choice over them. This, in turn, should lead to increased opportunities for self as-sessment and reflection; increased self-regulation.

Task control is strongly related to "learner control". In its broadest sense, learner control is the degree to which a learner can direct his/her own learning experience (Shyu & Brown, 1992). Instead of being the ob-ject of a lesson, the student is placed in a position of importance and control. More specifically, learner con-trol (Hannafin, 1984) is the degree to which learners control what is learned, the pace of learning, the direc-tion learning should take, and the styles and strategies of learning that are to be adopted. This list can (and should) be expanded to include control over the choice of methods and timing of assessment.

With respect to collaborative learning environments, this relates to questions such as: Who determines who does what within the learning situation? Who determines what the *legitimate* pedagogy, content and contri-bution is; What actions do students have to perform? Who determines which solution or solution path is most adequate, most applicable or best? Is it the teacher/coach who sets the general outline, conditions and constraints, or is the student or student group fully independent in selecting the relevant activities and learn-ing approach?

Conventional wisdom says that the more the learner controls his/her own instruction, the more rewarding the experience will be. Kinzie, Sullivan, and Berdel (1988) found that by transferring the locus of control from the teacher to the student, intrinsic motivation to learn increased and more satisfaction was derived from the learning experience, ultimately leading to improved academic performance. This has been backed up by other researchers who have determined learner control to be an essential aspect of effective learning (Kohn, 1993; Lawless & Brown, 1997; Lou, Abrami, & d'Apollonia, 2001). Research findings in this direc-tion are in accordance with the application of cognitive evaluation and overjustification theories. "Cognitive evaluation theory emphasizes the controlling aspect of performance-contingent rewards in reducing per-sonal autonomy or self-determination. The loss of perceived autonomy leads to a loss of intrinsic motiva-tion. Overjustification theory emphasizes the shift in attribution from internal to external sources that per-formance-contingent rewards produce. Both accounts predict that performance-contingent rewards are det-rimental to intrinsic motivation. to children for reading" (Cameron, Banko, & Pierce, 2001, p. 26).

With respect to learning tasks, by giving learners control they determine many aspects of their learning such as depth of study, range of content, and time spent on learning. With these options, learners can tailor the learning experience to meet their specific needs and interests. They are more autonomous, ask more ques-tions, and participate in more conceptually based information exchanges than students in traditional class-rooms due to an increase in perceived meaningfulness, self-assessment, and motivation (Kinzie & Sullivan, 1989) and increased feelings of competence, self-determination and intrinsic interest (Lawless & Brown, 1997).

On the other hand there is also a large body of research (for an excellent review see Williams, 1996) which shows that not all learners prefer nor profit from controlling the tasks (Carrier, 1984; Millheim & Martin, 1991), and that forcing such control on them can be mathemathantic (Snow, 1980; Rasmussen and David-son-Shivers, 1998).

Merrill (1983), for example, concludes that college-level students generally do not make good use of learner control options, a position also taken by Carrier (1984). The reason for this is that learners appar-ently do not have or do not know how to utilize appropriate strategies when they are left to themselves to manage their learning environment, i.e., they may not have the capacity to appraise both the demands of the task and their own learning needs in relation to that task in order to select appropriate instruction.

Snow (1980), a pioneer in Aptitude Treatment Interaction research argues that far from eliminating the ef-fects of individual differences on learning, providing learner control may actually exacerbate the differ-ences. Rasmussen and Davidson-Shivers (1998), for example, found that active learners preferred lower levels of learner control and performed best in structures that were highly controlled by others. Reflective learners, on the other hand, perform best when learner control options are available. In other words, one level of control does not fit all learners. High levels of learner control may prove counterproductive when applied to some learners.

Finally, Plowman, Luckin, Laurillard, Stratford, and Taylor (1999) determined that from the student's point of view teacher-controlled CSCL is a question of guidance while student-controlled learning is more one of construction.

Where is all of this going?

Educational and instructional design research should aim at the development of a comprehensive theory of instruction and instructional design for competency-based curricula and learning environments in post-secondary higher education. Ultimately, this theory should provide guidelines and tools. Instructional de-sign is not only a process for systematic development of instruction, but also a field of research aimed at the creation of guidelines for the development, implementation, evaluation, and maintenance of situations that facilitate learning.

What I propose here is a research and design approach dealing with a specific type of learning situation, namely one involving distributed learning groups (CSCL-environments). It emphasizes and stimulates re-search not only on the educational and technological aspects of CSCL, but also on the social aspects of learning in such environments and how these aspects interact with the educational and technological as-pects. It also defines three specific non-surface level factors central to the design of any environment, namely task ownership, task character and task control which will be central to research on the educational affordances of these environments. In other words, it is design centered research on supporting and stimu-lating learning in CSCL-environments.

According to Norman (1992), the major problem with most new technological devices and programs - and in my opinion also in their use in education - "is that they are badly conceived, developed solely with the goal of using technology. They ignore completely the human side, the needs and the abilities of people who will presumably use the devices" (p. 65). Good use – and that means both usefulness and usability - re-quires a design process grounded in user-centered instructional design research. I propose here a six-stage procedure for the research of CSCL-environments. These stages are:

1 Determine what learners actually do
We as educators and instructional designers must abandon our own perspective and study the learner's. We must watch students interact, observe collaborating groups interacting to solve problems, observe users interacting with software, et cetera, and do this before we begin to design and develop.

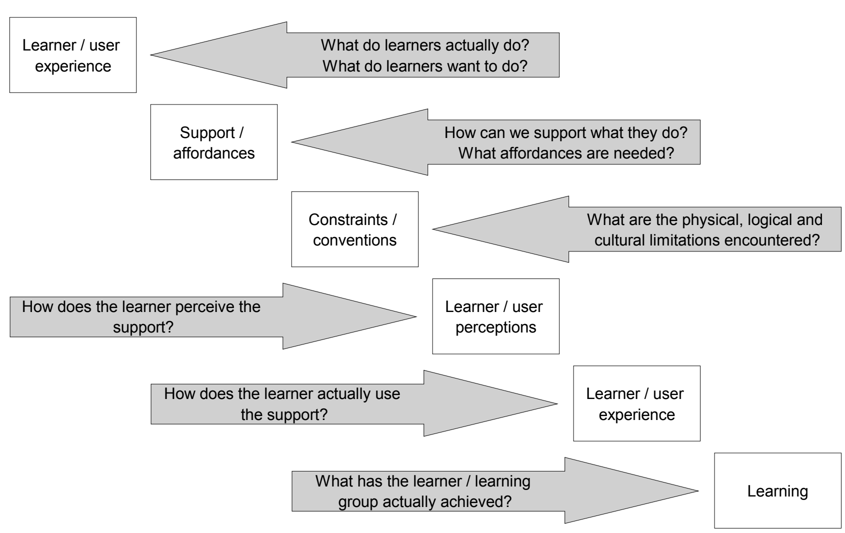
2 Determine what can be done to support those learners
We must not be seduced from our own knowledge and ideas to determine what is technologically, educationally, or socially possible and then build, implement or stimulate it. Instead we must deter-mine, based on stage 1, what actually needs to be supported / afforded and then proceed.

3 Determine the constraints of the learner, learning situation and learning environment and the conven-tions that already exist
What physical, logical and cultural limitations will we encounter when trying to implement support and what constraints will the learner encounter when trying to use that support? What conventions al-ready exist and are we introducing new ones? Of paramount importance here is that we look further than the technological constraints and conventions and take into account the educational and social constraints and conventions that play a role in CSCL. Denying or neglecting this will guarantee fail-ure, both of our work and of their learning.

4 Determine how learners perceive and experience the support that we provide
There is a world of difference between our (good) intentions and user perceptions thereof. We need to see and carry out research and design as iterative, interacting processes. We must verify our work by making ample use of prototypes, mock-ups and incremental design procedures. We must try these ‘products’ out with intended users at stages in their development where physical and conceptual changes can still be made. In this way we can assure not only the usefulness of the support (does it achieve what we want it to achieve?), but also the usability of that support (is it clearly defined such that its use is easily and correctly perceived by the learner?).

5 Determine how the learner actually uses the support provided
Analogous to stage 1, and following up the more formative evaluations carried out in stage 4 we need to determine if the learner actually does what we hope / expect that (s)he will do.

6 Determine what has been learnt
The goal of education is learning and there are three standards which can be used to determine the success of any instructional design, namely its effectiveness, its efficiency and the satisfaction of those learning (and also those teaching). An increase in one or more of these without a concomitant decrease in any of the others means success. This is the proof of the pudding.



Are two heads really better than one?

There's a radio show I often listen to called Car Talk® . Two dropout physics Ph.D.s who – disenchanted with university teaching – started a do-it-yourself garage in Boston and try to answer listener questions about cars (and lots of other things). On one occasion a caller posed a question about electric brakes on a cattle carrier. Unencumbered by the thought process as well as by any knowledge about electric brakes or cattle carriers, they waxed prolifically to give an answer. The next week the following letter arrived, which they read on the air (October 24, 1997):

> I am writing to offer profound thanks to you for resolving an important philosophical question … Do two people who don't know what they are talking about know more or less than one person who doesn't know what he's talking about?
> In your recent conversations regarding electric brakes on a cattle carrier, I believe you definitely answered this query … Amazingly enough, you proved that even in a case where one person might know nothing about a subject, it is possible for two people to know even less!
>
> One person will only go so far out on a limb in his construction of deeply hypothetical structures, and will of-ten end with a shrug or a raising of hands to indicate the dismissability of his particular take on a subject. With two people, the intricacies, the gives and takes, the wherefores and why-nots, can become a veritable pas-de-deux of breathtaking speculation.
>
> I had always suspected this was the case, but no argument I could have built from my years of observation would have so satisfyingly closed the door on the subject as your performance on the cattle carrier call. To begin your comments by saying, "We'll answer your question if you tell us how electric brakes work" and "We've never heard of electric brakes" and then indulge in lengthy theoretical hypostulations on the whys and wherefores of the caller's problem allowed me to observe that you were finally putting this gnarly ques-tion to rest.
>
> I am forever indebted to you for the great service you have performed! I'm truly impressed that it took so many years of listening to your show to finally have this matter resolved.

All joking aside, although it is apparently possible that two people can be dumber than one, we will assume that by working together people will be able to achieve more and different things than if they work alone. In business this means that solutions are more creative and innovative, that products are more effective and efficient and that businesses (both the employees and the company as a whole) get smarter. In education, this means that students learn more and institutions expand their resources to design, develop and deliver better education. For educators, this means that we must afford such learning environments.

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Invited Speaker

Understanding Collaboration in Learning- Related Information Seeking:
a Dialogic Approach

Understanding Collaboration in Learning-Related Information Seeking: a Dialogic Approach

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This paper presents findings from a study of collaboration during learning-related information seeking. The aim of the study was to identify the organization, functions, and types of 'dialogic' talk used by the participants as they collectively evaluate and make sense of the content of information retrieved as part of a learning activity. Although research has been conducted into the nature of dialogue during user-intermediary interaction for information retrieval little research has been conducted into the nature of peer interaction during information seeking and retrieval. Nine groups of undergraduate students were observed discussing the results of their information searches at the planning stage of a group investigation. A content analysis of the dialogues generated was conducted. The findings presented relate to the organization and types of dialogic talk used by the participants at this stage of the learning activity. Four types of dialogic talk were identified: exploratory, coordinating, disputational, and cumulative. The significance of these findings for learning-related information seeking and for studies of user-intermediary interaction is discussed. It is concluded that educationally-valued types of talk are transferable to situations of information seeking; and that the integration of information seeking research with studies of dialogue can enhance the study of information seeking in learning contexts.

Keywords: collaboration, learning, information seeking, discourse

1 Introduction

A user-oriented perspective on information seeking and retrieval that complements a more systems-oriented perspective is an established strand of research within the field of information studies. Recent research from a user-oriented perspective has begun to focus on context and the aspects of context relevant to the seeking and retrieval of information (e.g. Ruthven, Borlund, Ingwersen, Belkin, Tombros & Vakkari, 2006; Crestani & Ruthven, 2005; Spink & Cool, 2002). Two types of contexts that have received research attention are collaboration and task. Information seeking and retrieving is typically performed by individuals, sometimes in tandem with a professional intermediary. Settings are emerging however where information is sought, retrieved, and used not only by individuals but also by groups collectively participating in a larger unit of activity (Foster, 2006). When collaboration takes place as part of a larger unit of activity (e.g. work task, learning task) it becomes pertinent to consider not only the initial conditions of effective collaboration e.g. a common task but also the resources e.g. dialogue that participants draw upon to support effective collaboration as it unfolds.

2 Aims and objectives

The emergence of the study of collaboration in information seeking and retrieval has opened up the study of peer as opposed to user-intermediary interaction during information seeking and retrieval. This paper focuses on peer

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interaction during learning-related information seeking. One of the primary means through which collaboration gets done is dialogue. The paper reports on a study of peer interaction during an 'information task' performed as part of a broader learning activity. The aim of the study was to identify the organization, functions, and types of 'dialogic' talk used by the participants as they collectively evaluate and make sense of the content of the information retrieved; and to hypothesize as to the characteristics of effective dialogue when supporting the performance of information tasks.

3 Background

The study of users' interaction with human intermediaries and with interfaces designed for information retrieval has
The study of users' interaction with human intermediaries and with interfaces designed for information retrieval has
been a consistent field of research in information science. Part of this research has been concerned with the nature of effective dialogue for information retrieval. In commenting on a range of approaches to analyzing dialogue in other fields, approaches that might inform the "formal, goal-oriented communication system" of information retrieval, the authors of an early review of interaction in information retrieval stated that:

…all the various approaches have two common characteristics: the emphasis which they all place on the importance of shared knowledge to effective communication in the dialogue; and the insistence that it is the functions that take place, rather than the surface of the dialogue, which are of significance in discourse analysis (Belkin & Vickery, 1985: 66)

The importance attached to 'shared knowledge' for there to be effective user-intermediary interaction; and the emphasis placed on a functional approach to discourse has informed much of the research in the area. This research can be broadly categorized into that which has focused on user-intermediary interaction and which has sought to understand the character and functions of human-human interaction for information retrieval, so as to improve the effectiveness of such interaction for the retrieval of relevant information; and that which has focused on user-intermediary interaction for the purpose of modelling such interaction in order to inform the functional design of automated intermediaries. An approach that combines human-human and human-computer interaction has also been developed (Saracevic, 1996). Beaulieu (2000) proposes that interaction in information searching and retrieval be considered a discourse. The outcome of this research has often been the development of taxonomies of functions relevant to human-human interaction and human-computer interaction for information retrieval. For example: problem state, problem mode, user model, problem description, dialogue mode, relevant world builder, response generator, input analyst, output generator, explanation, secondary communication (Belkin, Brooks & Daniels, 1987; Belkin, 1984; Belkin, Seeger, & Wersig, 1983; Brooks & Belkin, 1983); context, terminology and restrictions, systems explanations, search tactics and procedures, review and relevance, action, backchanneling─prompts, echoes, extraneous; file, terminology, restriction, explanation and review, answers, idle (Saracevic, Spink, & Wu, 1997; Saracevic, Mokros & Su, 1990; see also Ellis, Wilson, Ford, Foster, Lam, Burton & Spink, 2002). Because of its centrality to intermediary-user interaction, research has also focused on elicitation behaviour (e.g. Spink, Goodrum & Robins, 1996; Spink & Sollenberger, 2004; Wu & Liu, 2003; Wu, 2005). This research has also led to taxonomies of the intended purpose of such elicitations e.g. to ask about terms, search procedures, databases, the current action or plan, and outputs (Wu, 2005). Such taxonomies, and the user models that can be derived from them, are clearly valuable for an analysis of interaction for information retrieval. Their application to and use as potential category systems for the analysis of the dialogue that occurs during learning-related information seeking is less apparent. This is for two reasons: (i) the learning-related nature of the information task that is driving the dialogue, and (ii) the multi-party, rather than dyadic, nature of the dialogue. Where a dialogue designed for the purposes of retrieving information can be considered to be driven by a terminological imperative, a dialogue for learning-related information seeking can be considered to involve the interpretation and use of the information within the context of the learning activity. The unit of analysis used to study dialogue during information retrieval interaction has also normally been the single utterance. The collaborative nature of the learning-related information-seeking context studied here however requires a unit of analysis that enables study of the learning activity and the utterances of a range of speakers. A category system that combines activity and multi-party interaction within a single analytical framework is now described.

4 Methods

4.1 Data collection

The collaboration and task context for the study of learning-related information-seeking was group investigation, a form of cooperative learning where knowledge is acquired and constructed within a social context of understanding (Sharan & Sharan, 1992). Table 1. presents the stages and main actions of a group investigation. Participants in the study were a class of ten students studying an undergraduate module in information management and strategy. The educational content of the module was organized around three themes: information policy, information audit, and information strategy. Each of the three themes was simultaneously investigated by three groups of students over a period of two weeks. Stage 4 of the group investigation at

Table 1. Group investigation

Stage	Description
1	Teacher introduces topic. Class determines subtopics for investigation and organizes into research groups.
2	Groups plan their investigations
3	Groups carry out their investigations
4	Groups plan their presentations
5	Groups make their presentations
6	The investigation concludes with the teacher and students evaluating their investigations.

which participants collectively review and discuss the documents that they have retrieved forms the particular focus of the study reported on here. At stage 4, which for the purposes of the research study was called an 'Information Task', participants were asked to complete three sub-tasks: (i) to share the information that they had retrieved at stage 3 (ii) to develop a collective response to the question under group investigation, and (iii) to plan a presentation on their findings to others in the class.

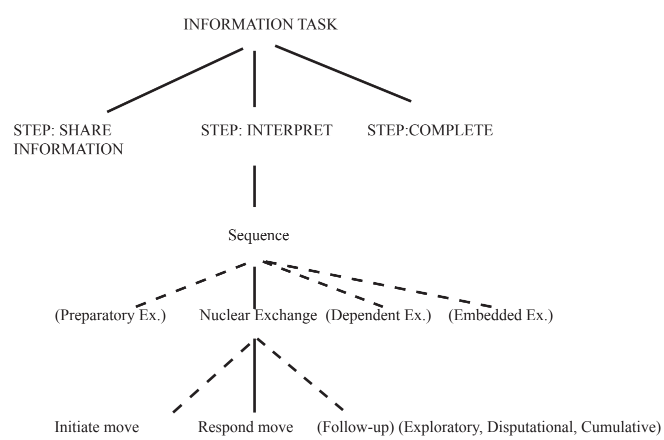

Figure 1. Analytical framework (Adapted from: Wells, 1999)

Nine face-to-face meetings took place at which the information tasks were performed. Participants in the study were required to participate in the meetings for the purposes of collectively generating ideas for a subsequent, individually-assessed essay component of the module. Participation in meetings was incentivised through the allocation of a single mark that contributed to the assessment for the module. To avoid bias during the data collection participants were unaware of the study's focus on understanding the nature of the dialogue used while the participants collectively make sense of the documents retrieved. Data elicitation methods consisted of the video-recording and transcription of the dialogues generated as students performed their information tasks.

4.2 Data analysis

A content analysis of the dialogues generated was conducted. The analysis followed a generalized framework for content analysis (Krippendorff, 2004) with a particular emphasis on a structuring of the content of the dialogues (Mayring, 2003). This structuring drew on an analytical framework 'the sequential organization of discourse' (Wells, 1999). Figure 1. presents the framework. The framework was adapted by adding what was known about the discourse organization of the dialogues before the analysis. The framework identifies the hierarchical and sequential organization of the dialogues by specifying both the task context within which the talk took place and the structure of the talk itself (into sequences, exchanges, and individual moves). Individual moves are the smallest 'building-block' of spoken discourse e.g. a question or an answer (Wells, 1999). Moves combine to make exchanges, and exchanges combine to form of sequences. The minimal exchange is of two moves (i.e. an initiating move and a responding move combine to form a nuclear exchange). One or more moves that follow-up on a nuclear exchange form a dependent exchange. Nuclear and dependent exchanges combine to form sequences. Wells (1999) identifies the 'exchange' as the appropriate unit of analysis for spoken discourse; while the 'sequence' is the key functional unit for joint activity by virtue of combining the nuclear exchange where initial expectations occur, with the succession of moves where either the initiating speaker or others follow-up on these initial expectations. The analytical framework first served as a resource for segmenting the information task dialogues. Thus the dialogues were segmented into those chunks of talk related to each step of the task; talk related to each step of the task was then segmented into sequences; sequences were further divided where appropriate into the nuclear and dependent exchange of they consisted. Finally each individual move was coded.

Table 2. Types of peer talk (Adapted from: Mercer & Wegerif, 1999)

Type of Peer Talk	Definition
Disputational talk	*Characterized by disagreement and individualized decision making. There are few attempts to pool resources, or to offer constructive criticism of suggestions. Disputational talk also has some characteristic discourse features – short exchanges consisting of assertions and challenges or counter assertions*
Cumulative talk	*Speakers build positively but uncritically on what the other has said. Partners use talk to construct a 'common knowledge' by accumulation. Cumulative discourse is characterised by repetitions, confirmations and elaborations.*
Exploratory talk	*Partners engage critically but constructively with each other's ideas. Statements and suggestions are offered for joint consideration. These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered. Compared with the other two types, in exploratory talk knowledge is made more publicly accountable and reasoning is more visible in the talk.*

Analysis of the dependent exchanges that follow-up on the nuclear exchange in a sequence was further specified with reference to three types of dialogical peer talk (Mercer & Wegerif, 1997) (see Table 2.). Thus dependent exchanges were categorized by virtue of the type of talk or 'discourse format' displayed by the participants during the exchange. The theoretical characteristics of these types of talk are now described. Illustrative examples of the types of talk taken from the dialogues are also presented.

Cumulative Talk

A distinct feature of the information task dialogues was the occurrence of summarizing sequences. Such sequences normally occurred at the closure of each step of the information task. Such summarizing sequences are characterized by the cumulative talk discourse format, during which participants acknowledge and confirm what has already been discussed, partly in order to display to each other that the information is part of their common ground and partly to act as a staging post in the accomplishment of the task. Such sequences also tend to be under the unilateral control of the speaker initiating the sequence.

(1)	A:	Right, so, OK.	Nuc.	I	Inform
(2)		First part before we come to here.	Nuc.		
(3)	M:	Yeh.	Nuc.	R	Acknowledge
(4)	E:	Yeh.	Nuc.	R	Acknowledge
(5)	A:	First part we talk about.	Dep.	I	Request confirmation
(6)		I'll talk about this.			
(7)		M.'ll talk about this.			
(8)	M:	Yeh.	Dep.	R	Confirm
(9)	A:	And you're going to talk about,	Dep.	I	Request confirmation
		Like the examples			
(10)	E:	Yeh.	Dep.	R	Confirm
(11)	A:	And the countries	Dep.	I	Request confirmation
(12)	E:	Yeh.	Dep.	R	Confirm

Figure 2. Cumulative talk

The cumulative talk exchange in Figure 2. occurs during a sequence extracted from the final 'presentation' step of one of the group investigations into the topic of information policy. N.B. the structure of this and subsequent examples is as follows: col. 1 = line number; col. 2 = speaker; col. 3 = utterance; col. 4 = type of exchange (nuc. = nuclear, dep. = dependent, emb. = embedded; col. 5 = type of move (I= initiating, R = responding); col. 6 = discourse move. The sequence structure in Figure 2. can also be divided into an initiating exchange, termed a nuclear exchange, and a series of dependent exchanges that 'follow-up' on the expectations set up by the initiating exchange (Wells, 1999) (Table 3.)

Table 3. Sequence structure (cumulative talk)

(1-4)	Initiating Exchange (Speaker 1)
(5-12)	Cumulative Follow-Up (Other task participants)
(5-8)	Cumulative follow-up 1 (Speaker 1/Speaker 2)
(9-12)	Cumulative follow-up 2 (Speaker 1/Speaker 3)

Exploratory Talk

Figure 3. is an example of exploratory talk. In itself exploratory talk is a type of collaborative talk characterized by speakers extending the previous contributions made by other speakers. The extract contains two instances of the use of an 'extend other' discourse move that leads to the identification and categorization of this sequence as exploratory in form.

(1)	J:	What—did anybody pick up this objective	Nuc.	I	Request positive/negative
(2)		in Orna, risk avoidance?			
(3)	A:	Yeh	Nuc.	R	Yes/No
(4)	M:	Yeh	Nuc.	R	Yes/No
(5)	J:	Short-term	Dep	I	Inform
(6)		So, I mean, that could be—	Dep.	I	Give opinion
(7)	M:	Could go into making information	Dep.	I	Extend other
(8)		More accessible and usable for the—			
(9)	A:	Yeh	Emb.	R	Acknowledge
(10)		Orna said about risk avoidance.	Dep.	I	Extend other
(11)		And then () said about			
(12)		Draws attention to problem areas			
(13)		Which kind of same thing isn't it,	Dep.	I	Request opinion
(14)		When you get () avoids risk			

Figure 3. Exploratory talk

Having agreed on a list of the benefits of information auditing as their focus for organizing their response to the information task, the participants proceed to collect information in relation to this focus; and the extract is taken from the information collection phase of the task. At (1-4) J. initiates the sequence with a nuclear elicitation exchange, inviting other participants to respond either positively or negatively to a potential benefit of information audits not previously discussed as part of their dialogue. Positive responses are first provided by two of the three other participants before each in turn extends John's initial point. M. follows up at (7-8) and A. follows up at (9-14). This sequence can also be divided into an initiating exchange, termed a nuclear exchange, and a series of dependent exchanges that 'follow-up' on the expectations set up by the initiating exchange (Wells, 1999) (Table 4.):

Table 4. Sequence structure (exploratory talk)

(1-4)	Initiating Exchange (J)
(5-14)	Exploratory Follow-Up (Other task participants)
(7-8)	Exploratory follow-up 1 (M)
(9-14)	Exploratory follow-up 2 (A.)

In sum, what the sequence demonstrates is one of the uses of exploratory talk during the Information Task, where the exploratory discourse format enables participants to jointly decide on an agreed categorization for a particular information resource.

Disputational Talk

A third type of collaborative talk is characterized by the participants' explicit use of counter-suggestions and rebuttals. This type of talk does not occur as frequently in the dialogues as the other types of talk. When it does occur it can occur during moments of debate or conflict. Figure 4. presents an example extracted from the 'focus formulation' step of one of the dialogues. The sequence demonstrates initial disagreement and eventual resolution among the participants about a schema for organizing the collection of information in support of the chosen focus.

(1)	J:	Could we try and pick out	Nuc.	I	Give suggestion
(2)		The tangible then first?			
(3)		And write that down?			
(4)	C:	I don't know if it's going	Nuc.	R	Reject
(5)	A:	()	Nuc.	R	()
(6)	C:	To be easier.			
(7)		It might be easier to listen,	Dep.	I	Give suggestion
C					
(8)		And then write, put 'T' next			
(9)		To that one.			
(10)	A:	() split the page in two.	Dep.	I	Give suggestion
(11)	C:	Alright	Dep.	R	Accept
(12)	A:	And then say (),	Dep.	I	Extend self
(13)		Say, y'know,			
(14)		Say, 'oh', that's a tangible			
(15)		And then put it in that column			
(16)		And we can (probably take it from there?)	Dep.	I	Give suggestion

Figure 4. Disputational talk

Disputational talk exhibits the same initiation-response-follow-up structure as cumulative and exploratory talk. In contrast however to both cumulative and exploratory talk, the initial expectations set by the initial exchange are not accepted and other participants' commitment to the suggested joint action is not, if at all, gained. The structure of this disputational sequence is as follows

Table 5. Sequence structure (disputational talk)

(1-6)	Initiating Exchange (J.)
(7-16)	Disputational Follow-Up (Other task participants)
(7-9)	Counter suggestion (C.)
(10-16)	Resolution (A.)

5 Results

An initial outcome of the content analysis was a revised coding scheme for the analysis of the dialogues. This coding scheme revised the analytical framework (Figure 1.) in light of the discourse data. In terms of types of talk this led to discovery of as four type of talk which was termed ‘coordinating talk’. Some brief information is provided here about the number of steps and sequences found in the data set before findings are presented on the types of collaborative talk that occurred and which forms the focus of the paper. Analysis of the nine information task dialogues yielded 36 steps and 224 sequences in total. Application of the analytical framework supported the division of the interpret stage into two sub-steps: ‘focus formulation’ and ‘information collection’ (Kuhlthau, 2004). Four types of sequences were identified: structuring, eliciting, informing, and summarizing. Of the 224 sequences, 170 (75.89%) led to dependent exchanges where other participants followed up on the initiating, nuclear, exchange. The mean number of sequences used to perform the information task was 25 sequences. As mentioned earlier a sequence can be divided into a nuclear exchange and a dependent exchange. It can be argued that one manifestation of collaboration during peer interaction is the occurrence of sequences where the content of the initiating, nuclear, exchange of one speaker is extended and followed up on by the other speakers. Thus after a sequence is initiated there are broadly two possible patterns of talk: either the initiating exchange is followed up by the initiating speaker themselves or the initiating exchange is followed up by the one or more of the other participants (including although not immediately a further turn-at-talk from the initiating speaker). The former type of dependent exchange can be termed ‘extension self’ and the latter type of dependent exchange can be termed ‘extension other’. In multi-party collaborative work it is the latter that is the typical pattern of talk.

Table 6. Dependent exchanges: Type and frequency

Type	Frequency	
Extension self	45	20.09%
Extension other	170	75.89%
Nuclear only	6	2.68%
Unidentified	3	1.34%
Total	224	100.00%

Table 6. summarizes the distribution of these two types of talk across the nine dialogues and highlights the overwhelming occurrence of extension other type sequences (75.89%). In only 20.09% of cases did sequences occur where the initiating speaker followed up on their own initiating, nuclear, exchange. Six of the sequences (2.68%) were categorized as only having a nuclear exchange and three sequences (1.34%) were unable to be identified as the exchange immediately following the nuclear exchange contained discourse moves that were indistinct and hence unable to be transcribed. For the purposes of this paper it is the further categorization of dependent, extension other, exchanges into different forms of collaborative talk that is of research interest. Table 7. presents the distribution of the types of collaborative talk across the nine dialogues. This highlights that ‘exploratory talk’ was the most frequently occurring type of talk (50.59%), followed by ‘coordinating talk’ (33.53%); with the remainder of the dependent, extension other, exchanges consisting of a combination of ‘disputational’ and ‘cumulative’ exchanges and a small number of unidentified exchanges.

Table 7. Dependent exchanges: Type and frequency

Type	Frequency	
Exploratory	82	48.24
Coordinating	63	37.06
Disputational	13	7.65
Cumulative	9	5.29
Unidentified	3	1.76
Total	170	100.00%

The type of collaborative talk occurring most frequently during dependent, extension other, exchanges was exploratory talk. This is all to the good since the aim of the information tasks and the group investigation more broadly was to encourage a more exploratory and critical approach to the evaluation of information and the construction of knowledge and understanding. This is an aim that is consistent with mean-making rather than mere accumulation of information. The majority of the exploratory talk occurred during the information collection step of the Information Tasks (59.76%) and was evidence of a systematic relationship between exploratory talk and the information collection step of the information task. Many of the information-seeking functions that were being performed at this step were followed up in an exploratory way by the other participants. These functions included requests for justifications and evaluations of a previous turn-at-talk. In sum such talk amounts to 'reasoning discourse' during which each speaker not only displayed their own reasoning but also engaged in transactive reasoning by discussing the suggestions and opinions of others. For example suggestions for presentation content could be followed up by others with a justification request or their own opinion on the suggestion supported by a justification for their opinion; suggestions for presentation structure could be variously extended and followed up by others with a justification request, or an opinion of the suggestion. In fact all information-seeking functions can potentially be followed up in an exploratory way. From an educational perspective such exploratory talk is to be encouraged. However over-exploration also occurred where a group investigation was characterized by a tendency for others to follow-up on the suggestions and opinions of others without proffering their own; such over-exploration was indicative of an underlying weakness in the investigatory process e.g. a lack of domain knowledge. Although accounting for only 7.65% of the sum total of collaborative talk, instances of disputational talk occurred most frequently in relation to participants' suggestions, in particular in relation to the key sub-task of formulating a focus for the group's response to the question under investigation i.e. disputation over suggestions for formulating the focus and the discussion of counter-suggestions. Other suggestions in relation to which disputational talk occurred included suggestions for how to structure the upcoming presentation and what to include in the presentation. Disputational talk also occurred where there were differences of opinion as to how to categorize an information resource and when discussing the meaning of an information resource. In sum disputational talk tended to occur during the focus formulation and information collection steps of the information tasks (there was only one case of disputational talk during the completion step) and in relation to key information task sub-tasks that involved some element of structuring e.g. the formulation of a collective focus, suggestions for presentation structure or content. It is worth noting that the occurrence of disputational rather than exploratory talk in a dialogue does not necessarily, although it may, imply ineffective collaboration during information-seeking. An element of disputation may indeed be productive and generative of effective investigation. This was the case for example in one of the investigations during which there occurred two exchanges of disputational talk in relation to the formulation of the focus, and yet performance on this information task was be considered to be the most effective of the nine information tasks performed. The majority of the cumulative talk occurred during the information collection step of the information tasks. During this step cumulative talk was used to confirm a pre-established focus, request opinions of the meaning of the information collected, request suggestions for focus, share information in support of a focus, request information in support and to suggest presentation content. Two instances of cumulative talk occurred during the focus formulation step: to request confirmation of focus and to give an opinion on information collected. Thus it can be seen that although instances of cumulative talk are concentrated during the information collection step the information-seeking functions with which cumulative talk was associated were quite various.

(1)	D:	Start off with…what Orna Says	Nuc	I	Give suggestion
(2)	M:	Yeh	Nuc	R	Accept
(3)	L:	Um	Nuc	R	Accept
(4)	D:	So you start off with Orna…	Dep.	I	Repeat
(5)	M:	Yeh	Dep.	R	Accept
(6)	D:	At the end you put, at the end	Dep.	I	Give suggestion
(7)	M:	[…] And then at the end	Dep.	I	Give suggestion
(8)		We can have like how			
(9)		To incorporate how,			
(10)		How what we found, and how Orna, Orna's			
(11)	D:	…compare what we	Dep.	I	Give suggestion
(12)	M:	…compare…	Dep.	R	Repeat
(13)		These are…you know	Dep.	I	Give justification
(14)		And these are all exactly			
(15)		Successful (or) constraining			
(16)		And then	Dep.	I	Give opinion
(17)		And that's it.			

Figure 5. Coordinating talk

The small percentage of cumulative exchanges meant that reliable testing of the association between this type of exchange and step of the information task was not possible. There is some evidence to suggest however that where cumulative talk does occur there is a tendency for this type of talk to occur as a dependent exchange during elicitation sequences rather than during other kinds of sequences. Instances of cumulative talk also tend to occur at points where there is a hiatus in the advancement of the task e.g. at the initial outset of the focus formulation step when information is shared but not taken up or at the initial outset of the information collection step as an external record of the group's problem response to the information task is being agreed upon. In sum the non-dialogic nature of cumulative talk is an indication wherever it occurs of less rather than more effective collaboration during information seeking. Common ground between the participants is cumulated although in a manner that does not admit to exploration and meaning-making. Application of the initial category system to the dependent exchanges also led to the discovery of a new type of collaborative talk. This was a form of collaborative talk that can be termed 'coordinating talk' and which derives from the task and collaboration contexts driving the dialogues. Coordinating talk was characterized by a series of exchanges during which an initial suggestion for action is then followed-up and completed by the others by taking up the action and more closely specifying or implementing the action suggested. An example of this type of talk occurring is provided in Figure 5. The structure of the sequence can be presented as follows:

Table 8. Sequence structure (coordinating talk)

(1-3)	Initiating Exchange (D.)
(4-6)	Extension Self (Give suggestion) (D.)
(7-17)	Follow-Up (Other task participants)
(7-9)	Counter suggestion (C.)
(10-16)	Resolution (A.)

Coordinating talk accounted in total for nearly a third of the dependent, extension other, changes (Table 7.) with the vast majority of these exchanges distributed fairly evenly across the Information Collection and Completion steps of the information tasks i.e. during the middle and concluding steps of the information task and not during the Focus Formulation step. A Chi-Square test confirmed a significant association between the type of collaborative talk and the step at which the type of talk occurred: Chi2 (6) = 18.453, $p < .005$. This is the case in four cases: exploratory talk and focus formulation, exploratory talk and information collection, coordinating talk and information collection, coordinating talk and completion. In the case of information collection it is exploratory talk rather than coordinating talk that is the more significantly associated with this step of the information task.

5.1 Discussion

The study has identified the different types and uses of dialogue that support the process of collaboration during learning-related information seeking. The study provides evidence to support the claim that dialogic forms of interaction rather than the more constrained forms of user-intermediary interaction are the appropriate form of interaction for peer interaction during learning-related information seeking. The most frequently occurring form of collaborative talk was observed to be exploratory. Such exploratory information-seeking is akin to attempts to characterize information-seeking as sense-making (Dervin, 1999) and meaning-making (Yoon & Nilan, 1999). Coordinating and disputational talk were also identified are valued forms of talk for supporting the process of collaboration during learning-related information-seeking. It can be hypothesized that it is likely that effective collaboration during learning-related information-seeking is associated with the use of such discourse formats. The study has also pointed to the development of norms for the appropriate levels of use of such collaborative talk. For example, although exploratory talk is an educationally valued from of talk and, it is claimed here, a valued form of information seeking interaction, over-exploration can lead to digressions in the task and may be indicative of other weaknesses as well e.g. a lack of domain or problem-solving knowledge. Similarly, over-use of coordinating talk may be indicative of a superficial approach to the task where priority is accorded to the coordination of participants' actions (e.g. organizing roles for the upcoming presentation) rather than the meaning of the documents retrieved. The identification of the types of collaborative talk and more particularly, the association of types of talk with the steps of the information task can also underpin the development of a template outlining the norms for the types of collaborative talk or discourse formats found by participants to be most useful during the accomplishment of learning-related information tasks. Empirical evidence in support of the use of such discourse formats can also be supplemented by other theoretically valued discourse formats as possible options (e.g. disputational talk). Such learning-related information tasks can be implemented in face-to-face and in computer-supported collaborative environments. If the latter the application of argumentation software may prove valuable. In either there are also implications, as there are for intermediaries more generally, for human intervention when individuals or peers are unable to progress the task without external intervention. In this regard the study points to the forms of collaborative talk that a tutor might encourage, e.g. the use of exploratory or coordinating talk, when breakdowns in learning-related information tasks occur.

6 Conclusions

This paper has presented findings from a study of learning-related information-seeking and the types of 'dialogic' talk used by the participants as they collectively evaluate and make sense of the content of the information retrieved in support of the learning activity. Four types of talk were identified: exploratory, coordinating, disputational and cumulative; with exploratory talk being the most frequently occurring and used discourse format. Both exploratory and disputational talk can be considered to be educationally-valued types of talk that are transferable to the situation of learning-related information-seeking where information is not only sought and retrieved but also interpreted and presented within a broader context of activity. Coordinating talk was also identified as a valued form of talk when seeking information collaboratively. It can be concluded that studies of information seeking that focus on the seeking of relevant or pertinent information can be productively integrated with studies of dialogue when taking account of the use of the information and its application within a learning context.

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Conference Papers

Themes and Topics

ICT in Teaching and Learning
Technolocigal Tools in Education
Play and Game-Based Learning
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ICT in Teaching and Learning

Intertextual Elements of Children's Explanations: The Development of Children's Explanation Processes in Technology-Enriched Science Classrooms

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This paper discusses a longitudinal study that investigates the development of children's explanation processes in technology-enriched science classrooms. Of particular interest are the intertextual elements of children's explanations constructed into being in collaborative peer groups in kindergarten and second grade science classrooms. Theoretically, the study highlights the potential of sociocultural perspectives of learning and development to provide new insights into the processes of children's explanation generation during collaborative problem-solving supported by technological simulations (Mercer, 1996; Wells, 1999). The methodological foundations of the study draw upon developmental psychology and sociolinguistics as well as on earlier studies on collaborative peer problem-solving and learning (Kumpulainen & Wray, 2002; Littleton & Light, 1999). The empirical data of this study were collected in two phases and involved a classroom community of 22 children, aged between six to eight years. The same children were observed in their science classrooms at a kindergarten setting as well as during their second grade. The learning activities and tools in the science unit consisted of child-initiated, exploratory activities during which children had versatile tools in their use, including a multimedia learning tool, PICCO. The preliminary results indicate that studying the intertextual elements of children's explanations provides a fruitful platform to investigate children's explanation processes when they are making sense of the world whilst engaging in scientific inquiry. The children's explanations were found to draw on textual and material links, hands-on explorations, i.e. activity links, as well as on recounting events. Moreover, the preliminary results show that inquiry-based science learning embedded in dialogic learning activities and the application of technological tools enriches the intertextual character of the children's explanation processes. (Kumpulainen, Vasama & Kangassalo 2003, 2006). The study reported in this paper is part of PICCO-research project (e.g. Kangassalo and Kumpulainen 2003, 2004). PICCO is an ongoing research project that investigates children's science learning and thinking in social context of a multimedia environment. The project will broaden and deepen the existing research work of the research partners particularly in relation to young learners' conceptual thinking and learning of science within the social contexts of technology-enriched classrooms.

Keywords: early childhood education, intertextuality, peer-centered learning, science learning

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1 Introduction

In these days all Finnish six year old children are entitled to pre-school education by law. This has brought pressure for people on the early years educational field to re-organise pre-school education and to change its characteristic. Previously, pre-school was more or less an environment in which the children just obtained day care while parents were working. Nowadays pre-school education has been seen more as a part of the schooling system, like a starting class which produces conditions for the diversified development and gives learning possibilities for every child. (Havu, 2000). Providing the learning environments in which the children can express themselves and discuss with the other peers and teacher is a challenge for nowadays pre-school educators

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Finnish pre-school curriculum (Opetushallitus, 2000) places emphasis on conceptual disciplines in daily activities and cognitive topics, such as Finnish readiness to read and write, mathematics, environmental education and science education.

The main aim of the Finnish pre-school curriculum (Opetushallitus, 2000) is to develop children's view of the world. Accordingly, this developmental process is seen to be established through the children's observations and emotional experiences in the environment were they live. The view of the world consists of pre-school activities including the cognitive, social and affective aspects. (Havu, 2000). It is clear that the children construct their social roles through play; they also learn social interaction and collaboration among each others. It has become important for teachers and researchers to understand better how social interaction and collaboration is constructed between early years learners while working in peer groups on various activities. In addition to contemporary views of learning, including child-centred learning activities and collaborative working modes, it is vital to pay attention on the learning environments as well. Consequently, it is important to investigate the features and development of children's collaboration and social construction of meaning in computer-mediated peer activities.

Research has indicated that using computers in the classroom is rich ground for social interaction, as children frequently prefer working with a peer to using the computer alone (Haugland, 1997, 2000). Consequently, the role of technology in early childhood education is a controversial topic. Parents and educators have concerns about potential benefits or harm to young children. Critics contend that technology, meaning the use of computers, in education wastes time, money and childhood itself by cutting down on essential learning experiences. On the other hand, proponents suggest that children should have the advantage that new technology can offer. The controversy around the use of computers in early childhood education revolves around the specific needs of young children and whether technology can support those needs, or will take away from important developmental experiences (Haugland, 2000). Studies around the use of computers with children stress that when properly used, computers and software can serve as catalyst for social interaction and conversations related to children's work. A classroom set up to encourage interaction and the appropriate use of the technology will increase, not impair, language and literacy development. According to various studies computer use enhances children's self concept, and children demonstrate increasing levels of spoken communication and collaboration. Children also share leadership roles more frequently and develop positive attitudes towards learning (Clements, 1994; Cardelle-Elawar & Wetzel, 1995; Denning & Smith, 1997; Haugland & Wright, 1997; Haugland 1997, 2000). Computers allow for development, adaptation, and delivery of tools that may facilitate more effective thinking, problem solving and learning (Haugland & Wright, 1997).

2 Theoretical rationale

The broader theoretical rationale on which this research study is grounded derives from sociocultural perspective to learning and development (Brown, Collins & Duguid, 1989; Cobb & Bowers, 1999; Greeno, 1997; Lave, 1988; O'Connor, 1998). This approach views learning as a process of enculturation which develops through participating in socially situated cultural activities with more knowledgeable members of culture (Rogoff & Toma, 1997; Wertsch, Hagström & Kikas, 1995). In these perspectives language and other semiotic tools have an important role in mediating the development of social understandings which are gradually internalised to be reflected as intramental habits of mind (Vygotsky, 1962, 1978; Wertsch, 1991).

In the sociocultural framework language is seen as a tool for thinking. Consequently the two are seen as closely related (Vygotsky, 1978). Disciplines, such as science are constructed by unique ways of thinking and acting employing specific linguistic registers (Lemke, 1990; Varelas & Pappas, 2003). The sociocultural approach conceptualises science learning as an interactional process which includes learning the discourses and social practices of scientific communities (Herrenkohl & Guerra, 1998). For the sociocultural framework science learning is viewed as an enculturation process into a community. Here, the traditional view of knowing as possessing is replaced by the concepts of belonging, participating and communication (Sfard, 1998; Schnotz, Vosniadou, & Carretero, 1999; Wenger, 1998). Also scientific explanations involve the construction of new conceptual entities and related linquistic expressions (Ogborn, Kress, Martins, & McGullicuddy, 1996). Accordingly, science learning can be viewed as entailing a new way of seeing and new way of talking about it (Kaartinen & Kumpulainen, 2002).

For inquiry-based science education, explanation construction is an important element to be cultivated in instructional practice. Via the promotion of explanation generation in science classrooms, students are provided with opportunities to gain an understanding of the ways in which to conduct scientific inquiry. This requires constructing an understanding of "the epistemic game" (Collins & Ferguson, 1993) of participating in scientific inquiry. That is, understanding the nature and goals of scientific inquiry and the social practices via which the desired explanations and theories are constructed (Schauble, et al., 1995). With regards to scientific explanation, this involves constructing an understanding of specific reasoning strategies and manipulations of the representation that allow particular forms of knowledge construction (Collins & Ferguson, 1993).

In recent years there has been extensive research on early learning that is organised as an interaction among peers. Some research traditions argue that younger children find learning this way intrinsically difficult. Piaget's theorizing suggests cognitive change occurs within peer interaction but also that, during the early school years, children lack the necessary psychological resources to learn and interact effectively in collaborative situations (Crook, 1998). On the other hand, in peer interaction children express their opinions more freely than with adults and metacognitive supports are shared (Verba, 1994). Still the way in which different opinions, definitions and interpretations are expressed and created in peer interaction is usually very complex and dynamic in nature (Cohen, 1994; Hicks, 1995; Maybin, 1991). The development of children's conceptual explanations around the themes of earth, space and time has been widely investigated (e.g. Baxter, 1995; Kangassalo, 1997; Panagiotakopoulos & Ioannidis, 2002; Vosniadou, 1994; Vosniadou & Brewer, 1990, 1992, 1994). Less attention has been paid to the intertextual links children make to support or refute their conceptual claims during scientific inquiry. In peer interaction children must cope with silences, negotiate how, when and who talks and asses the relevance and quality of their communication (Barnes & Todd, 1977, 1995). Consequently, the intertextual links made in explanation construction, provide a fruitful platform to investigate children's authentic practice of making sense of the world whilst engaging in scientific inquiry. Moreover, the intertextual connections made by science learners are found to serve as important catalysts in developing scientific understanding as well as scientific registers (Varelas & Pappas, 2003).

In sum, investigation of social interactions within various educational environments is significant, not only because social development is a fundamental goal, but also because these valuable interactions are essential components of children's cognitive growth.

3 Aims and objectives

The main goal of this research study is to illuminate the nature of children's explanations emerging in a technology-enriched classroom during science unit focusing around natural phenomena. Of particular interest are the social and intertextual elements of children's explanations both at early years and at school level. The overall goal of the study is to investigate how the inquiry-based science unit, including its tools and activities, created the children social spaces to engage in the activity of explaining, and how these explanation processes develop over time when children move from early years level to school level.

These perspectives hopefully give insight on how children build up their skills of social interaction in a learning context based upon child-initiation, exploratory activities, social interaction and the application of multimedia technology. At a methodological level, the aim is to develop new analysis tools to capture the situative dynamics of social interaction in child-child interactions and social activities. This study also investigates how children's social interaction develops from the perspective of developmental psychology. This includes taking account of both individual, social interaction as well as social norms perspectives on interaction. Moreover, this study provides insights into the meaningful application of multimedia in an early years classroom.

4 Study

Data sources. The empirical data of the study was gathered in two phases. First phase of the empirical data was collected from a Finnish early years science classroom community consisting of 22 children aged between six to seven years old. Of the 22 children, thirteen were girls and nine were boys. The children represented a mainstream of children in the Finnish society. To get the developmental psychology view on empirical data, the data collection was reproduced with same children at the age of eight to nine years. The data for the research project was collected by means of video-recordings covering pre- and post adult-child interviews and children's self-initiated activities and interactions within the social context of the multimedia science learning tool. Children's exploration paths during the use of the multimedia environment have also been recorded. Subsidiary data of the project consist of teacher interviews and parent diaries. (Kangassalo, Kumpulainen & Vasama 2003.)

Pedagogical context. The pedagogical culture of the classroom community investigated in this study followed inquiry-based learning modes where a specific emphasis is placed upon the shared experiences of the learning community framed by social interaction, voluntary communication and joint meaning making (Wells, 1999). Children participate in the inquiry as active members who explore issues and problems of their interest, reason together and share expertise. Collective discussions often arise from children's questions which are usually embedded within a particular theme or problem guided by the curriculum.

Technological tool. Peer-centred learning activities during the science unit utilized a Pictorial Computer-based Simulation program, PICCO (Kangassalo 1991/1999). The simulation program has been developed for children's spontaneous exploratory activity with the goal of supporting their conceptual learning whilst interacting with the environment. The pictorial multimedia program concentrates on the natural phenomenon in earth and space level. There is also a possibility to research nature phenomenon according to the concept of time. Picco multimedia program has been designed in a way that a child may explore the science phenomena from familiar to unfamiliar, from everyday experiences to more distant ones, thus, the program models the phenomena according to children's own interests. In the program all necessary elements are represented as pictures and familiar symbols. All the pictures and views on the screen in changing situations have been constructed and represented so that they form peaceful and aesthetically valuable scenes, which is important to the user. Peaceful and harmonious scenes give the user a chance to pause, seek for something, or just look at the view very quietly. This supports a child's attention and concentration on the exploration process of the phenomenon, which again helps in imprinting things in their memory. The use of PICCO is based on the users' own activity. It is important, that children can proceed according to their own interests and ideas. In the program, there are no paths or rules on how to explore and go forward. Children can use as much time as they like each time. All this provides the user with possibilities to explore the phenomenon any time as long as they want and in the order as they so wish. The program is very easy to use and there is no risk of getting lost in it. A child can explore the phenomenon either alone or together with a partner. The program does not presuppose a reading ability. (E.g., Kangassalo, 1992, 1997).

Modes of Inquiry. The data for the study were collected by means of video-recordings covering pre- and post adult-child interviews and children's self initiated activities and interactions within the social context of the multimedia science learning tool, PICCO.

Dialogic interviews between an adult and a child. All children who participated in the study were interviewed at the beginning and at the end of the science learning unit. The interviews aimed at illuminating children's conceptual models of natural phenomenon in question. The mode of interview was dialogic in nature, enriched with hands on activities, e.g. modelling of clay into the shape of earth and sun (visualization of the phenomenon) and describing various science phenomena through pictures.

Peer-centred activities. During the science learning unit, the children had the ability to conduct their science investigations with the PICCO multimedia program freely according to their own interests. The explorations around the technological tool were realised in solo activity or in child-selected dyads or small groups. This period lasted for four weeks. Figure 1 below highlights the children's social activity and exploration around the PICCO program.

Figure 1. Peer-centred science inquiry around PICCO

4.1 Data analysis

The interviews and peer-centred activities around the social context of the technological tool were videotaped and transcribed in full. The transcribed video data was inserted into a qualitative analysis program, Nvivo. In order to gain an understanding of the thematic context(s) of peer interaction, it has been important to conduct a content analysis first. The unit of analysis for the data-guided content analysis was an episode. A thematic episode was regarded as finished when a new theme was identified to be taken into the discussion. After several readings of the transcripts, 13 themes were identified in the interaction. Namely these were: *math, writing, technical, role negotiation, personal, birds, flora, day-night, months, seasons, map, animals and space*. Figure 2 summarizes the themes identified from the data.

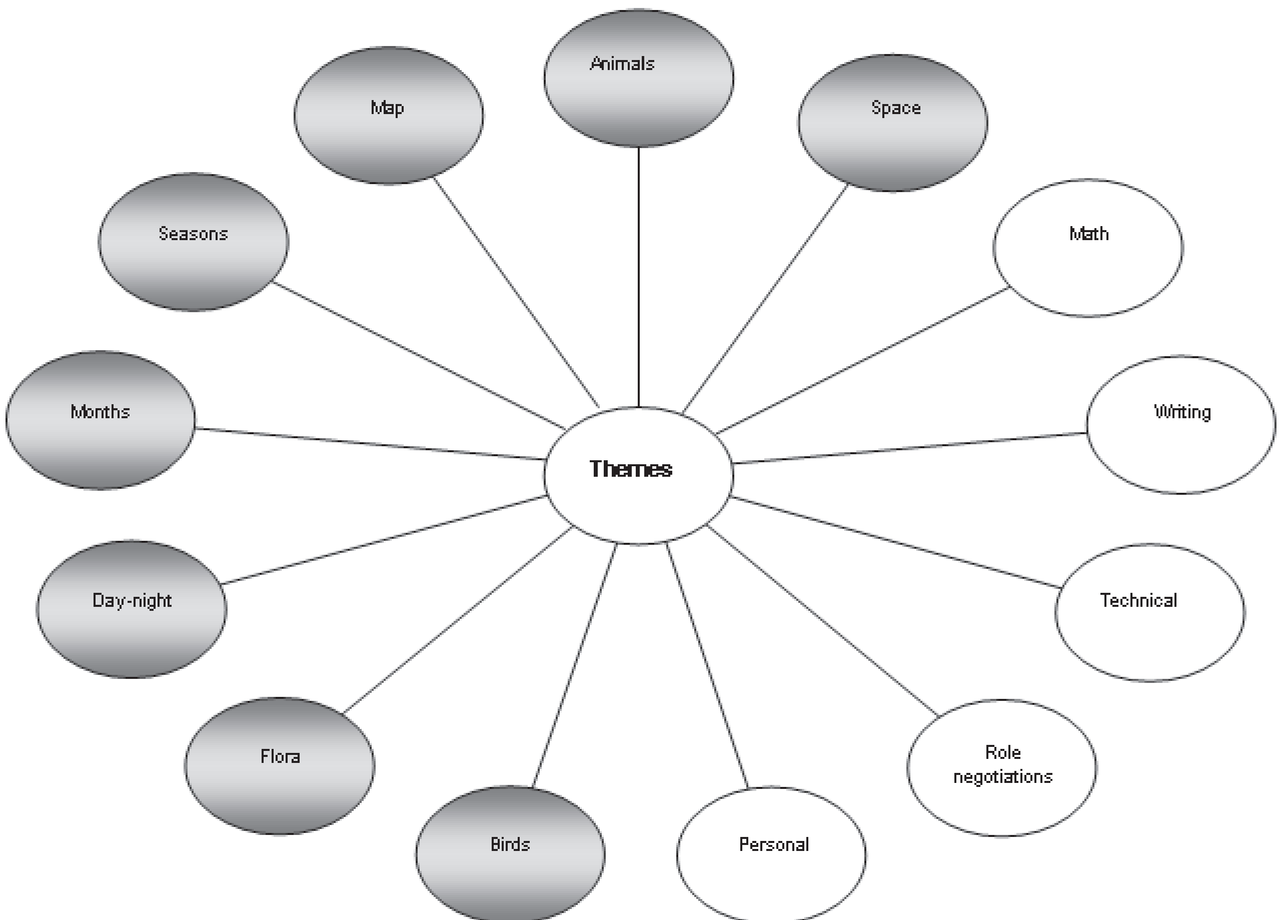

Figure 2. Thematic analysis

Secondly, all science-related utterances expressed by the children were identified and extracted (see Figure 2, highlighted circles with grey). Thirdly, the identified science-related explanations were investigated several times in order to establish a typology of categories characterizing the intertextual nature of the explanations. The classification and categorization of the intertextual nature of the children's explanation have been influenced by earlier studies investigating students' explanations in science classrooms. (Kumpulainen, Vasama & Kangassalo 2003, 2006.) Namely, the typology of intertextuality is grounded upon the work of Varelas and Pappas (2003). Fourth phase of the analysis was to choose few case examples of the children's social intercation and investigate how the social elements of children's explanation processes develop over time when children move from early years level to school level. This longitudinal micro-level analysis of the data is still undergoing.

5 Results

The results of the analysis of the pre-school level suggest that inquiry-based early years science instruction which values learners' problematisation, authority and accountability and which is enriched with relevant technological resources is able to create rich contexts for explanation construction. (Kumpulainen, Vasama & Kangassalo 2003, 2006). In this social context science gets constructed via diverse discursive voices and explanations (Engle & Conant, 2002). The science learning context investigated in this study provided the children with many opportunities to share their questions, ideas, and explanations upon which the classroom members would contingently respond to make sense of the world (Lindfors, 1999; Wells, 1999; Windschitl & Andre, 1998). The possibilities to participate in scientific inquiry and share perspectives promoted the emergence of heteroglossia (Bakhtin, 1981) of diverse discursive voices towards science.

The technological resources embedded in the children's activity contexts as well as hands-on practices served a significant role in the children's explanation construction and elaboration. Here, the children were able to approach science via the cross-examination of theory and data, a process defined by Varelas and Pappas (2003) as "theory-data dance". The social sharing and investigation of technological resources along with the engagement in hands-on explorations enabled the children to go back and forth between a variability of explanations based on different types of contextual knowledge, including everyday and scientific registers.

The children's explanations during the science unit were found to draw on textual and material links, hands-on explorations, i.e. activity links, as well as on recounting events. The intertextual richness of the children's explanations particularly in terms of making connections to their experiences, highlights the significance of this social context for explanation elaboration. Moreover, this finding indicates that inquiry-based science learning activities are powerful contexts to examine children's explanations and the sociocultural contexts in which they are embedded. These intertextual linkages functioned as tools for the children (a) to share and validate previous experiences as sources of knowledge, (b) to establish reciprocity with each other in meaning-making, (c) to define themselves as learners of science and as individuals with specific experiences and background (d) to construct, maintain and contest the cultural practices of what it means to do and learn science in the classroom. (Kumpulainen, Vasama & Kangassalo 2003, 2006). Taken together, these intertextual links and the functions they served constructed a local culture and genre of doing science in this classroom (Lemke, 1990). In this culture the children appear to learn to understand the value and applicability of their experiences as tools for problem-solving and thinking in science. Here, the children are likely to learn to think with their experiences – not only to think of them (Enedy, 2003). The following extracts and accompanying descriptions highlight the intertextual richness of the children's explanations constructed during the science-learning unit in preschool level. The extracts are derived from adult-child dialogic interviews and peer-centred activities around the multimedia tool, PICCO.

Textual and material links in the children's explanations

The analysis of intertextuality in the children's science-related explanations reveals that the children often made reference to *textual and material links* whilst supporting and/or refuting their conceptual claims during their investigations. Whilst juxtapositioning *written texts* in their explanations the children made reference to institutional texts, such as school books, children's story books, non-fiction books or personal texts, e.g. diaries and letters. The linking of *oral texts* in the children's explanation generation drew on verbally-mediated activities during which the children made reference to stories which they had, for example, shared with grandparents. In addition, they recalled prior discourses constructed in peer-groups. *Other media links* also served an important role in the children's explanations. Here, the children made reference to TV and radio shows they had experienced. Also the multimedia science learning tool, PICCO, was integrated by the children into their explanation construction in order to demonstrate, argue and warrant their science-related claims.

Table 1 shown below illuminates the intertextual features of the children's explanations, namely the making of reference to an institutional text, i.e. Winnie the Pooh, as well as to PICCO, multimedia tool. As the examples demonstrate, these intertextual linkages functioned as tools for the children to construct reciprocity in meaning-making with their working partners.

Table 1 Textual and material links

Textual and material links	Examples	
Written texts a) Institutional texts b) Personal texts Oral texts a) Cultural heritage b) Prior discourses →	Annarauna: Teacher: Annarauna: Teacher:	In Winnie the Pooh book, he thought that the earth is falling down They have invented such things The earth falling down! Well, okay.
Other media a) Tv/radio shows and movies b) PICCO, the multimedia science learning tool →	Sini: Teacher:	The moon does not shine its own light; it shines the sun's light. Cause, PICCO tells similar things than in the space book Well yes

Activity links in the children's explanations

The intertextual analysis of the children's explanations demonstrates that hands-on practices served a significant role in the children's explanation construction and elaboration. From a broader perspective, it appears that the linking of hands-on explorations into explanation generation facilitated the children to construct an understanding what it means to do and learn science during inquiry-based activities.

The *activity links* identified in the children's explanations made mostly reference to *hands-on explorations* in the immediate context of their activity. Also previous experiences related to hands-on investigations in the context of the classroom or in other settings played a role in the children's explanation generation. Table 2 shows an example of peer-centred inquiry with the multimedia science learning tool, PICCO. Here, the children make reference to on the spot explorations whilst investigating and explaining the rotation of the earth.

Table 2 Activity links

Activity links	Examples	
Hands on explorations a) On the spot b) In the classroom c) In other contexts →	Anna: Saara: Anna: Saara: Anna: Saara: Anna: Saara: Anna: Saara:	I want to see this! This is not real You mean this? No Yes It has been created with a computer but it looks real That is real Yeah but the earth does not rotate so quickly. It rotates like this. You cannot even see it (demonstrates) It rotates like this No, like this. Look in a month there is a rotation like this, and a second, and a third one. Okay.

Recounting events in the children's explanations

The analysis of intertextuality shows that the science learning context in which the children worked provided them with opportunities to make reference to events they had encountered earlier. These drew either upon specific and/or generalized events. When making reference to specific events in their explanations, the children recounted on events in which they had personally been involved (i.e. personal specific events) or they made links to specific events that their peers or family members had experienced (i.e. personally-related others). At times, the children also referred to impersonal specific events in their explanations, such as making reference to a specific earthquake that had taken place. In addition to specific events, the children constructed their explanations by making reference to *generalized events* which occur more regularly either in their own life or in the world in general.

In sum, *recounting* events made it possible for the children to share and validate previous experiences as sources of knowledge. When making recounts in their explanations, the children made their experiences visible and allowed them to become an object of discussion and reflection. In this social context, the children showed evidence of having epistemic authority and accountability in meaning-making. These activities are powerful in helping the children to define themselves as learners of science and as individuals with specific experiences and background (Engle & Contant, 2002).

Table 3 summarizes the intertextual linkages the children were identified to make in their explanations in terms of recounting events. The accompanying examples highlight the children's making of reference to specific and generalized events when explaining.

Table 3 Recounting events

Recounting events	Examples
Specific events a) Personal specific events b) Personally-related others involved in specific events c) Impersonal specific events	PICCO: Waxwing. Henna: I have seen it Saara: Me too several times Henna: Once with my father
Generalized events a) Personal generalized events b) Personally-related others involved in generalized events c) Implicit generalized events	Bobby: Yes, my birthday is then when it is the 29th Saara: My birthday is during the summer Paula: Mine is when it is 25th Saara: Is yours in March?

6 Conclusions

Educational tasks in Finland have been lately under reconstruction aiming at developing the educational system continuously and to increase the possibilities for life long learning. Moving towards a more learner-sensitive, communicative and meaningful direction in learning and instruction requires new attitudes and expertise from all people involved the educational processes. The ultimate goal of learning is to establish authentic learning communities in which the inquiry is based on equal participation in social interaction among the members of the community.

It seems that peer-centred inquiry is a powerful context to investigate children's collaboration and social construction of meaning. Dialogically oriented classroom activities embedded in inquiry-based learning modes with modern technology provide the children with many opportunities to share their questions, ideas, and explanations upon which the classroom members would contingently respond to make sense of the world (Lindfors, 1999; Wells, 1999). This is likely to have implications upon instructional practice as well.

In sum, the importance of investigating the social interaction and collaboration among early years science learners is reflected in the fact that in today's society social skills and collaboration are a crucial mean for everyone to cope with the authentic and complicated problems of everyday life. Consequently, the investigation of the structures of collaboration and social construction of meaning from the perspectives of the developmental and educational psychology is important, as the pedagogical practises learned at an early age seem to be carried on in later life as well. By investigating the language and social interaction from the perspectives of the developmental and discursive psychology, it is hoped that this study unravels important features of how children build up their skills of social interaction in a learning context based upon child-initiation, exploratory activities, social interaction and the application of multimedia technology.

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The Roles of the Teacher in Using ICT: Examples of Four Types of Teachers

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Information based society requires changes in the culture of teaching. Student-centred teaching methods have been adopted, student-teacher relationship has changed. In order to investigate how teachers see their role and whether they are prepared to introduce information and communication technology (ICT) into the instructional process, a study was conducted in eleven Estonian schools. A questionnaire was filled out by 300 teachers, 44 of whom were chosen to be interviewed.

According to the results, teachers can be divided into four types.

1. Teachers who do not use ICT media are content with their traditional roles as distributors of knowledge. They tend to be set in their ways and their attitudes take longer to change.
2. Teachers who use computers as their personal tools might be motivated to start using ICT in teaching by outside pressure.
3. Teachers who seldom use computers in the classroom are in need of knowledge of learning software and relevant teaching methods.
4. Teachers who actively use computers in teaching would be good role models to those who are not capable or lack the courage to use computers in their lessons.

These four types of teachers differ in their perceptions of teacher's role, their approach to teaching and their usage of computers. The study also revealed that teachers' perceptions of their role, their concepts of teaching and learning, and actual usage of ICT in instructional process are interrelated.

Keywords: instructional process, usage of ICT, concept of teaching and learning, teacher's role

1 Introduction

Introduction of information and communication technology (ICT) into the teaching of different disciplines requires changes in the perception of learning and in the culture of teaching. As stated by Lehtinen (2003), ICT plays a significant role in the development of theoretical approaches to the teaching process. Different technological possibilities, new concepts of the instructional process and the roles of the teachers and students are shaking teachers' existing beliefs and understandings of teaching. Tella (1997) admits that a new approach means greater teamwork and cooperation within a group, shared responsibilities and expanding the learning environment beyond the classroom. The fact that both the teacher and the student can work in an electronic learning environment, will change the traditional teacher-centred

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teaching (Learning to Change…, 2001; Tsitouridou & Vryzas, 2003). Therefore, the adoption of ICT modernizes the instructional process (Becker & Ravitz, 1999; Säljö, 2003) – teacher-student relations change and different learning methods are introduced. To promote the integration of ICT into the teaching of special subjects, teachers' perceptions of their tasks and their attitudes toward teaching should change (Wang, 2002). Activities designed to transfer knowledge from the teacher to the student are replaced with those supporting active creation of knowledge by the student. This makes traditional teaching more and more complicated and brings changes to the teacher's role. Consequently, the adoption of ICT in instruction requires changes in the instructional process and a new approach to teaching.

Teachers' primary tasks while using ICT are to teach students to learn and help them organize information (Lehtinen, 2003), providing them with individual support, at the same time taking into account their differences, learning styles, previous knowledge and interests. The individualization of teaching means that the teacher does not have a monopoly of presenting knowledge, taking on a broadened role of mediating the learning of individual students. The teacher designs, organizes and re-adapts activities to help students apprehend the structure of the subject, integrate parts, act, use feedback and reflect on their learning experiences (Lim & Barnes, 2002).

The findings of several studies (Atjonen, 2003; Becker & Ravitz, 1999; Hativa, 1998) show that according to teachers there is a huge difference between traditional and computer-based learning and teaching: in the latter case it is the teacher's task to help students organize their activities and integrate the acquired material into a whole. ICT is considered a pedagogical means, the effective use of which supports student-centred learning. However, Toots, Plakk and Idnurm (2004) admit that the spread of information technology does not automatically bring pedagogically successful solutions. Quite frequently teachers do not consider using computers in their teaching essential, or use computers in ways favourable to their own interests, reflecting the individual teacher's perception of teaching (Wang & Reeves, 2003). As Atjonen (2003) notes, the choice of the teaching materials, teaching aids or methods depends on the environment and the particular user.

Student-centred teaching requires teachers' readiness for continuous self-improvement and learning together with their students. In addition, they should master behavioural strategies, being able to shift from merely presenting knowledge to teaching students to think and learn. In order to achieve such a qualitative change in school, teachers should become advisers, mentors and guides apart from being distributors of knowledge (Atjonen, 2003; Barajas, Kikis, & Scheuermann, 2003; Eesti Edu 2014, 2004).

To investigate teachers' role perceptions and how Estonian teachers see their possibilities of updating the instructional process and integration of ICT into the teaching of different subjects, a research was carried out in schools of Estonia.

2 Aims and objectives

The study tried to find out how teachers use computers in teaching, how they view the modernisation of the instructional process and acquisition of knowledge and skills by integrating ICT into subject teaching, and what their perceptions of their role in a classroom equipped with computers are. The aims of the research were to find out:

- Teachers' perceptions of a professional teacher's role (e.g., teachers' attitudes toward improvements, usage of student-centred methods, etc.);
- How teachers perceive ICT contribution to teaching and learning;
- How ICT is used in the subject teaching.

3 Methods

3.1 Sample and procedure

The sample of maximum different case, founded on the basis of the results of the research Tiger under Magnifying Glass (Toots, 2001), was used for the study. The size of the school (basic or secondary school), location (urban or rural school) and types of school (e.g., coeducational day school, Step by Step) were taken into account, when selecting schools. 11 schools were selected where a total of 300 teachers (123 primary and 177 secondary school teachers) completed a 25-item questionnaire. Then, based on the responses, teachers with entirely different backgrounds and subject areas, possibilities, experiences and frequency of using computers were selected (e.g., does not use computers and does not want to use them; does not use computers but would like to use them; frequently uses computers). The final sample comprises 44 teachers: 22 primary school teachers and 22 teachers of humanities (e.g., history, social studies, natural science, literature and languages).

41 female and 3 male teachers between the ages of 26 and 62 with the teaching experience of 2 to 35 years were interviewed. The schools where they work vary widely in the state of being furnished with computers.

3.2 Measures

Semi-structured interviews consisted of 14 main questions. The questions included demographic data, teachers' perceptions of a professional teacher (e.g., what kind of knowledge and skills a qualified teacher should possess; what kind of training is needed to promote teacher professionalism); and their vision of the teacher's role (e.g., roles performed by them in the instructional process; the advantage and disadvantages of applying ICT with regard to the teacher's role). Some questions were aimed to find out the teachers' ICT-related competences, the reasons and intensity of using/not using computers, their major problems and need for schooling, motivation and attitudes toward integration of ICT into the teaching of subjects.

The interviews were recorded on a digital Dictaphone. An observation sheet was used to record the interviewer's observations and notes. For analysis the interviews were transcribed by a method called note expansion (Mahoney, 1997). The data were coded and grouped into categories so that all the essential points of the interviews were included in the notes in accordance with the research aims.

4 Results and discussion

According to analysis of interviews four types of teachers with different behaviour and attitudes as well as different perceptions of using ICT in teaching can be distinguished.

1. Teachers who do not use and have never used computers (8 female teachers).
2. Those who only use computers as their personal tools for preparing lessons (16 female and 2 male teachers).
3. Teachers who seldom use computers in the classroom (10 female teachers).
4. Teachers who actively use computers as innovative tools in the instructional process (7 female and 1 male teachers).

These four types of teachers differ in their methodology of using computers (e.g., ICT-based, student-centred or teacher-centred methods), needs for schooling and their perceptions of a teacher's role. Each type was represented by teachers of different ages with different lengths of teaching experience.

1. Teachers who do not use ICT means consider delivery of knowledge from the teacher to the student essential and do not regard ICT as a student-centred approach. They are of the opinion that a professional teacher knows well the subject taught by them and is a good communicator. They are convinced of the advantages of traditional methods, having an inner fear to lose control over the teaching process. They value discipline and try to maintain order in the classroom. They are happy with their present role – a teacher is a distributor of knowledge – and are convinced that teachers who know much can make their students smart.

> *# 6: A good and professionally skilled teacher knows his subject well, is intelligent and demanding.*

> *# 4: I teach, give guidance, check. I tell them what exactly they are expected to do. This is what the teacher's role used to be and still is.* (This opinion is also shared by teachers 14, 35 and 43).

In order to maintain their position in the classroom, and to be liked by their students at the same time, they compile work instructions and are in charge of their students' activities. According to Wang (2002) such teachers still believe that teaching is the didactics of forwarding knowledge and learning is a passive activity.

These teachers overlook the importance of computer literacy. They consider both internal and external factors as serious obstacles to integration of ICT into subject teaching: limited computer resources, locked computer labs, the scarcity of good software or the teacher lacks the skills to use it, no courses in computer studies offered. Because of inadequate experience, integration of ICT into subject teaching is a time- and energy-consuming undertaking. They claim that using computers involves much danger: children do not learn to read and grow away from books. Computers are alleged to be harmful to their health and may cause social separation.

> *# 10: I wonder, what sort of people the chat room and messenger users will turn out to be.*
> *How will they develop their face-to-face communication skills?*

Teachers feel responsible for their students' academic progress, and according to some of them a lesson should be spent on more important things than just playing with computers (teacher 4, 10 and 33).

The teachers of this type are of the opinion that the improvement of technical possibilities would motivate teachers to use computers in teaching. According to Christensen (1998) the role of ICT in the school curriculum will increase positively when teachers can practice using computers in their daily work. Unfortunately, these teachers believe that they are not in need of schooling, for they consider their professional development and teaching experience sufficient.

Teachers' beliefs and attitudes toward ICT-assisted learning are hard to change. As long as teachers are convinced that the teaching methods chosen by them are effective and guarantee results, it is complicated to persuade them to use more modern ones. Experimenting with something new means extra work (Guskey, 2002; Learning to Change…, 2001). High risk to fail is a threat to their devotion to teaching.

As they tend to be set in their ways, their attitudes take longer to change. But social pressure, such as curriculum requirements to use ICT in subject teaching, support of the administration, the interests, needs and initiative of children and their parents can contribute to changes.

2. According to teachers who value computers as their personal tools, qualified teachers have good subject knowledge and are good at transmitting knowledge to their students. These teachers appreciate the necessity of computer literacy and the knowledge of learning software. They consider communication skills and pedagogical ability, as well as competence in ICT essential for a teacher.

> *# 8: It is my task to teach, to pass on knowledge. Whichever methods I choose is up to me.*
> (Opinion shared by teacher 16).

In their opinion, the teacher's task is to coordinate and facilitate the learning process, to develop students and to provide them feedback.

Teachers of this type use ICT as a means of collecting information to make their lessons more interesting and substantial. They value the computer as a typewriter helping them to prepare their lessons. They use office software (e.g., Word, Excel) to make worksheets and tests. Worksheets are interesting to students, and teachers do not need to spend any extra time and effort on individualization of teaching.

> *# 39: I use the Internet to search for additional materials. It is possible to solve a problem in different ways. It is my task to check how a student solves it, or how much he can do.*

The teachers consider the integration of ICT into the lessons necessary mainly because it is one of the requirements of the Estonian National Curriculum (Põhikooli ja gümnaasiumi…, 2005), but they do not use computers in the classroom. They believe that introducing a computer-based innovation occupies much time. Guskey (2002) finds that teachers initiate up new activities if they can effectively link them with former activities practised in class. They will not either give up activities they find necessary or replace them with new ones. If the teacher is not convinced the new activity is necessary, he will not use it.

> *# 7: …[as to innovations], first you need to get acquainted to them. This is an additional task. But once you haven got used to them, they will facilitate your work /.../ and make it easier.* ***(Also teacher 15).***

Citing these teachers (e.g., teachers 5, 8, 19, 32 and 39), the improvement of technical conditions and abundance of modern computers would motivate teachers to use ICT in their teaching. If teachers had better skills or knowledge of the software, they would use computers together with their students in the classroom. They are in need of comprehensive training (computer skills and introductions of software) accompanied by technical and methodological support. By offering training in advanced ICT methods, it is possible to change the beliefs and attitudes of these teachers about student-centred teaching. Positive experiences, assistance from the ICT teacher and the head teacher's support are essential.

Hence, the adoption of ICT in teaching has contributed to making work easier and more productive for teachers of this type. But as they are not convinced that using computers can really make a difference in teaching and learning, they do not use computers together with their students.

3. Teachers who seldom use computers with their students consider good subject knowledge, mastery of different teaching methods as well as creativity as crucial qualities of a qualified teacher. But they fail to understand that delivering computer-assisted lessons is one of the student-centred teaching methods. These teachers have the basic computer skills and although in general they recognize the necessity and value of computers for education, they rarely use computers in their own lessons. For them the computer is a means of facilitating the teacher's work: they can use it to introduce the new material or to consolidate knowledge. These teachers prepare electronic learning materials (e.g., websites), but do not have their students use them in the lessons.

The teachers of this type lack the confidence to use computers in the classroom, as they do not know how exactly to use them within their own subject areas of teaching. They are neither familiar with computer-based methods nor prepared to give their students ICT competences through the teaching of particular subjects. In their opinion, using computers in subject lessons should not be obligatory. It is up to teachers to decide whether or when to use them. As Christensen (1998) mentioned, the main reason why teachers do not use computers together with their students is the lack of relevant knowledge and experiences in the field of ICT, which makes them unconfident and alienated from computers. Citing these teachers, they principally see external factors as major obstacles to their using of computers in teaching.

> *# 16: It's not possible to equip all students with computers, that's why it is complicated to organise the teaching. But a special timetable for the computer classroom could help.*

In fact, the scarcity of computers in schools is not an objective reason for not delivering lessons in the computer lab. The student-centred usage of computers requires the knowledge of different teaching methods and designing the curriculum and development of assessment methods. According to the teachers of his type the use of ICT in subject teaching means first and foremost the need for knowledge of the operations a computer can perform, not the knowledge of computer-assisted learning. These teachers are not convinced that adoption of computers in subject teaching would substantially change the teaching and learning or improve the quality of lessons and student achievement. However, Guskey (2002) admits that there are teachers who apply new activities but fail to notice any change in their students' academic performance, and there are also teachers who participate in training but fail to use in the classroom what they have learnt. These teachers are in need of schooling and they need to be taught about software.

Although the computer plays an important role in these teachers' everyday work, they do not think that their role in computer-assisted instruction differs much from their role at a traditional lesson. It is a teacher's duty to teach and coach students, to support and motivate them.

We cannot speak of any changes in teachers' roles, if they use ICT for only a single activity in the computer classroom without any follow-up activities, either daily or weekly. As pointed out by Lim and Barnes (2002), we can speak of a professional development of the teachers' ICT usage if opportunities are created for the teachers to learn and refresh their knowledge and if they are willing to use these opportunities, and use ICT in teaching to a significant extent. Offering them computer courses and software introductions to help them successfully integrate ICT into the curriculum should support these teachers.

4. The teachers who can be classified as active users of computers in teaching hold the opinion that a teacher's knowledge of ICT and mastery of modern teaching methods are crucial for professional teaching. These are innovative teachers who keep themselves updated. They consider computer-based instruction interesting for the students, motivating them to learn better and enhancing instruction. Teaching with computers is more resultant than traditional teaching and causes change in student and teacher roles.

These teachers have good technical skills and they use the computer for personal purposes and also for teaching in the computer-equipped classroom. ICT helps vary the lessons – teachers can choose whether to use PowerPoint presentations, or do either individual or group work, or have students play language games. Thus, it is possible to develop different partial skills and develop children's creativity, sense of imagination, thinking and social skills. Several of them underlined that in computer-assisted instruction it is easier to individualize the learning process and take the students' abilities and needs into consideration.

> *# 21: Changes in society as well as changes in student values and attitudes require changes in teachers' professional development. / ... / A teacher can't focus on only subject matter knowledge, as students want to know more and more. New possibilities have given us more options and also taught us to take into account students' specific individual characteristics.*

> *# 15: They [children] are more attentive and keen on learning. The student who is eager to learn has better achievement.*

Computer-based teaching is a modern method, which motivates children to learn and helps create a working atmosphere in the classroom.

We agree with Barajas, Kikis and Scheuermann (2003) and Wang (2002) who point out that introduction of computers into the teaching processes helps make the learning environment more autonomous for the student and facilitate collaboration with the teacher as a partner and guide. These teachers see the computer as a useful device helping to achieve teaching goals, acquire new knowledge and "to lure students into learning". Teachers believe that while using ICT in the classroom their major task is to supervise and direct students. The teacher creates conditions for individual or group work and supports each group and each of its members with appropriate methods. Thus, teaching turns into an activity where the teacher has a leading role but in which he is not the only participant.

> *# 11: Supervise. No need to teach subject-specific content. Everybody can do that…but there a lot of children in need of individual supervision. (Also shared by teacher 28).*

> *# 42: It isn't the teaching that matters, but showing the way towards quality education. It's important to teach how to learn.*

Teachers who actively use computers in teaching perceive changes in their role (e.g., partner, individualizer, motivator, and supporter) and the need to turn teaching into an active student-centred activity. The teacher's role includes that of a partner, individualizer, developer, motivator and supporter. These teachers consider themselves computer literate and do not need any motivation.

Teachers of this type should be involved in computer training. Teachers' workshops might demonstrate the possibilities of computer-based instruction and application of student-centred teaching methods to computer-assisted teaching. They could be mentors or guides, sharing their experiences and skills.

5 Conclusions

Although distribution of knowledge to students, their counselling and increasing student achievement have been teachers' main tasks, different teachers may use different activities and approaches for completion of the same task.

The study findings showed that in case of the first and *second types of teachers* (do not use computer; use the computer as their personal tools), the teachers' concept of teaching and learning and their traditional roles have not changed: the teacher is mainly the distributor of knowledge and assessor, but the student is the recipient of knowledge (Figure 1).

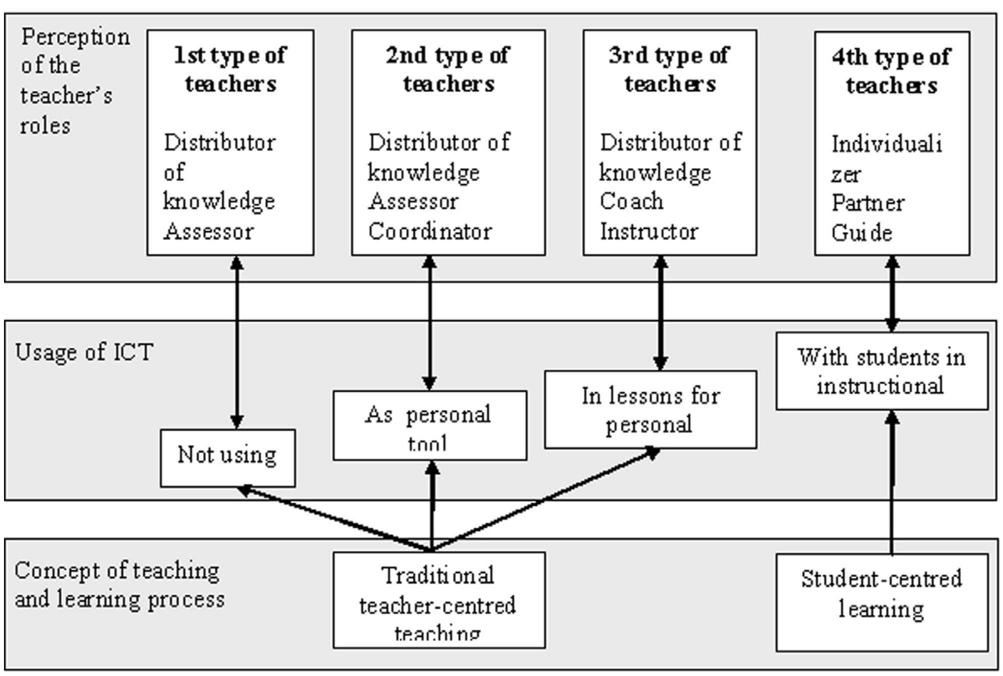

Figure 1.
The relationship between concepts of teaching and learning, usage of ICT, and teachers' role perceptions.

Teachers of these types have not abandoned either traditional teaching methods or the belief that qualified teachers have good knowledge of the subjects taught by them. They are convinced that traditional teaching methods support their students' development and help receive the best results. Teachers of the first type use neither new opportunities nor new teaching media. Teachers of the second type use ICT means, but with a view to strengthen their existing positions. They consider their own goals and do not take into consideration their students' changed interests in ICT. These teachers would need schooling, technical and methodological support.

Teachers of the third type are of the opinion that modernization of the instructional process can motivate and support students. Nevertheless, they use ICT tools in a way which supports teacher-centred teaching, the major reasons being the lack of the knowledge of learning software and ICT-based student-centred methods. They are in need of consolidating their computer-related knowledge.

We are faced with a conflict: although a number of teachers recognize the usefulness and necessity of using computers in teaching, they are not ready to use them. There is a relation between teachers' acceptance and usage of technology and their conceptions of the instructional process. Teachers do not realise that application of the many possibilities of ICT requires different approaches to teaching and learning. The main roles that teachers have to perform are the roles of distributor of knowledge, coach, and instructor, but they do not perceive that using computers may cause great changes in their conventional teaching. Changes in teachers' perceptions of their roles have elicited an increase in their usage of ICT. Teachers' inner readiness is required, well as outside support.

The *fourth type of teachers* should be involved in computer training. They could be mentors or guides sharing their experiences and skills. Their main roles in the instructional process include those of individualizer, motivator guide and supporter. They prefer teaching with computers, because ICT-assisted teaching helps them to perform these roles. They would be good role models for the teachers who are not capable or lack the courage to use computers in their lessons.

Consequently, teachers' perceptions of their roles, their conceptions of teaching and learning and their computer-assisted instruction are interrelated. Using or not using computers in the classroom with students is also affected by teaching styles, i.e. if a teacher is willing to abandon the traditional teacher-centred teaching and the role of a distributor of knowledge, he or she will introduce ICT tools into the teaching process. Although there is a commutative connection between the usage of ICT tools and the changes in the conception of the teaching process, they have an impact on the teacher's role (see Figure 1). All things considered, we believe that it is not enough to train teachers to use ICT media. It would be more important to change their philosophy of teaching.

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Suitability of Web-Based Learning for Different Learners

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Web-based learning is seen as an opportunity to take part in studies to graduate or improve oneself in any university in the world. Teachers have to educate themselves continuously. As on-line learning is more time-flexible and place-flexible, it could be an effective method for that. But is this kind of learning suitable for all teachers? A study, which investigated the factors related to the suitability of web-based learning and the perception of studies in a web-based learning environment, was carried out in Estonia. The data were gathered using the essays, which were analyzed by using qualitative content analysis method. Also, the statistical data about the participation provided by WebCT were used. These data were analyzed with the help of cluster analysis. Results indicated that factors related to suitability of web-based learning could be divided into three major categories: skills of computer using, personal characteristics of a learner and the participation in the learning process. All these related factors are developmental. Therefore web-based student's preparation should start already in comprehensive schools.

Keywords: web-based learning, teachers' education, characteristics of learners, learners' perceptions

1 Introduction

Internet is a powerful communication tool in education (Downing, 2001; Jain & Getis, 2003). On-line learning is considered as to be an effective method of instruction (Downing & Chim, 2004). Web-based learning in the University of Tartu began in 1998 and year-by-year the percentage of on-line learning has successively enlarged (Hansmann, 2003). Is the web-based learning suitable for all students? Do all the students benefit equally from this form of learning?

2 Aims and objectives

The aim of this study was to ascertain which factors are connected to the suitability of web-based learning in Estonia and how in-service teachers perceive studies in this form.

3 Literature review

Internet is considered as an important communication tool in education (Downing, 2001; Jain & Getis, 2003) and on-line learning is considered to be an effective method of carrying through studies (Downing & Chim, 2004). The usage of Internet and its studying environment in higher education has been successively increased (Hoskins & van Hooff, 2005).

The following is considered to be the advantages of web-based learning (Hoskins & van Hooff, 2005):

- Bigger opportunities to give feedback to students
- Bigger support to students
- More flexible learning

- Engaging larger number of students
- Motivating different students
- Cheapness
- Students have bigger anonymity
- Practicing general skills (self-regulation, co-operation, searching for information etc)
- An opportunity to expand and understand obtained experiences better
- Developing computer skills

Terms web-based learning and on-line learning are mostly used as synonyms. Web-based learning can be defined as learning, which is imparted to the student completely, or partly by the Internet or Intranet (Trombley & Lee, 2002). Therefore, web-based learning is only one form of e-learning and one form of distance education. Alessi and Trollip (2001) differentiate two forms of web-based learning:

1) On-site learning, where students learn web resources, using them in a class,
2) Distance learning, which is organized as the cognition process of the studies, which does not require the students to be physically presence.

Web-based learning is often combined with traditional (face-to-face) learning (Fung & Carr, 2000). Kerres and De Witt (2003) define this kind of learning as a blended learning.

In case of web-based learning it can be both synchronous communication and asynchronous communication. Blended learning definitely contains both kinds of communication. In case of synchronous communication partners of communication take part in the communication at the same time (call, traditional studies, online chat rooms, Messengers etc.). Asynchronous communication does not expect that communication partners can communicate at the same time (e-mail, mail, forums lists etc.). Kerres and de Witt (2003) declare that synchronous communication is more suitable to reach a shared understanding (convergence); at the same time asynchronous ones are better for the exchange of information (conveyance).

In order to carry through web-based learning people use different internet-based learning environments (called also a virtual learning environment), which enable access to studying materials and communication with co-students and with the lecturer (for example WebCT), and both video technique and audio technique (videoconferences, video lectures) to the students. This kind of environments support teaching, studying and learning (Lehtonen et al., 2005).

Vuorela and Nummenmaa (2004) declare that besides studying environment web-based learning also contains technical (interaction between student and technique) and social (interaction between student and lecturer and co-students) environment. Also, Lee and Tsai (2005) bring out three components of web-based learning: the person (learner), machine/system and activity; and two connections: person-machine (dimension of Internet-based learning environments, which mainly deal with the interaction between a person (learner) and the system or content provided by the machine) and person-action (interior dimension of Internet-based learning environments, which focuses on how the person is engaged in the activity).

Whereas web-based learning contains several aspects, then besides studying skills are also important student's technical (computer) skills, computer self-efficacy, self-regulation skills and communication skills (Lee and Tsai, 2005). Passey (2000) declares that the biggest challenge in web-based learning is teaching lifelong learning skills and independence, which students often do not have. Hoskins and van Hooff (2005) bring out that in the case of web-based learning students have a chance to practice general skills, such as self-managing, and gain computer skills. It is also discovered that people, who have better computer skills, specially those, who have experiences with the usage of Internet before the course, manage easier in web-based environments and are more active there (Lee and Tsai, 2005).

Interaction between lecturer and co-students in computer-based environment is confusing for several people, because they get lost in asynchronous environment and cannot understand, who is talking to whom and about what. Big amount of messages confuses them; that is why such people often stay observers (Tu & McIsaac, 2002). Tu and McIsaac (2002) declare that interaction in web-based learning is influenced by students' interaction and of the consciousness of the perception of other persons. The presence of co-students in web-based learning is not so distinguishable as in traditional face-to-face learning (Vuorela & Nummenmaa, 2004).

Every student interprets studying situation differently according to his/her own individual experiences and acts in web-based learning according to his/her own expectations and interpretations (Järvela, Lehtinen & Salonen, 2000). That is why it is important to study not only collaborative work, but also individual students in web-based learning (Vuorela & Nummenmaa, 2004). As about students' characteristics, student's their gender influences students' participation in web-based learning. In web-based learning male students communicate more with the lecturer and co-students (Hoskins & van Hooff, 2005). Researches about age are contradictious. Hoskins and van Hooff (2005) have found that older students take part more actively in web-based learning, Morrell and his colleagues (2000) have found that they take less part than younger students. Students, who take part in web-based communication, are academically more capable and have higher achievement score (Hoskins & van Hooff, 2005).

4 Methods

33 students on master level (all in-service teachers) took part in web-based course named 'Methodology of computer assisted instruction' in WebCT environment, which also included 10 hours of studies in auditorium (6 hours in the beginning of the course and 4 hours at the end) in spring 2006. 28 students (85%) reached the preliminary examination. Information for this research was collected by the essays, where some directing questions were given. In the beginning of the course students wrote about their experiences and contacts with computers and at the end of the course about how this kind of learning suited to them. 26 students wrote both essays. Essays were analyzed using qualitative content analysis. Besides were used student's statistical materials from WebCT resources. Students were grouped by hierarchical cluster analysis on the basis of these data.

5 Results

The results of essays that were written after the course demonstrated that web-based learning did not suit at all to 4 students (1 man and 3 women). In some aspects this kind of study suited and in some aspects did not suit to 10 students (3 men and 7 women) and this kind of learning was totally suitable to 12 students, who were all women. The groups of students are as follows.

5.1 Web-based learning does not suit

Surprisingly, younger students (age 25-35 years) belonged to this group. Women in the present group related to the computer with dislike *(Maybe my dislike to computer has came from that I am not very competent in this matters.)* or were not interested in computers at all *(This is not the subject what I would feel any professional interest to.)*. Computer was used only in case of necessity *(I use the computer really only how much I need.)* and mostly for working and communicating by e-mail. A male person of this group had good computer skills but he admitted that he was dependent on computer games.

On the basis of the second essay it appeared that they were people who could not plan their time well and bringing big workload, family problems etc as a reason they said that in the case of such course the feeling of flabbiness, that they cannot manage, emerges *(In the evenings and at the weekends it took a lot of effort to sit again in front of the computer. Exercises ran very fast and continuously I had the feeling that I cannot manage.).* These people needed the lecturer to be present, that the lecturer continuously helped, directed and checked them at the same time.

> *I also need the support from the lecturer. One quick demonstrate is not enough for me. Revision is needed to fix the learned material. And revision with the support from the lecturer. I have repeatedly seen for a moment, what can be done with the computer, but I can't do all this alone. The lecturer must also be present.*

Students from this group were not motivated to learn. They took part in courses rather for credits, not for knowledge-skills, they took part because it was a compulsory subject. The co-students, communicating with them and co-operation did not figure in their writings.

5.2 Web-based learning suits in some aspects

Both younger and older students (age 24-52 years) belonged to this group. They also rated their computer skills very differently – there were people, who rated their computer skills as to be very good *(Now doing teacher's job, computer is like a part of my body.)*, people, who rated their skills as average *(I can't say that I am a good friend with the computer. Rather an acquaintance.),* and people, who rated their skills to be as beginners ones *(Even now I think of myself as a beginner computer user.).* In addition to using computer as a working tool, people in this group use the computer also as a communication tool (besides e-mail also MSN) and for searching information.

As about the arrangement of web-based learning, they thought that from one side freedom to plan your time is good, but at the same time such flexibility caused the adjournment of the activities. So, they asserted that from one side freedom is good, but from the other side this expects time planning skills and self-discipline *(I admit that this is the mistake of my bad planning.)*. It is easier to attend the studies in auditorium, and then one doesn't adjourn his/her activities.

> *So yes, I am rather a person who shows up and does the job. This web-based learning maybe leaves too much room for mobility, it means you can adjourn and dawdle activities.*

People in this group needed more severe limits and punishments, and motivation from outside *(Deadlines in the timetable should be obligatory, when you outgo deadlines, then you have to do an extra exercise or you lose points or something like that. I think that strictness about work deadlines would be really useful.)* and they needed continuous reminders (I would like to receive an e-mail – that I have to finish off something just now.).

If people of the first group did not perceive the presence of the lecturer and brought out the absence of the lecturer as a disadvantage of the course, then the lecturer existed for the people of that group and they knew how to use the resources the course offered. The timetable, reminders sent by the lecturer and the existence of the schedule of the course helped them to manage with the studying exercises.

> *At first I was more pessimistic if I could follow the timetable and won't get too lazy if I don't have to see the lecturer from face to face. Now I see that I couldn't exactly follow the timetable, but the feeling that the lecturer exists was there. She was not as a negative or displeased side but as a supporter and acceptor.*

> *First thing I did when I joined the course was printing out the schedule and putting it on the nearest wall beside the computer. As there isn't any continuous contact with the lecturer within a web-based learning (I don't have to go anywhere on certain time etc.), so a paper on the wall at least reminds me that I am on the course and I have to log in WebCT, and there are deadlines etc. Then it is easy to lose the discipline and unavoidably you remember things that actually take place are more.*

The most positive thing about web-based learning was said to be that you can learn when it suits to you (evening, night) and concentrate in peace on what you are learning. They asserted that this form of studies advances more proper learning of the subject and more meaningful participation. It could be read out from the writings of the people of this group that they gained from reading thoughts of other people.

But I also think that as the participation in seminar is impulsive, so the oral answer comes out from my mouth without thinking. Here people think more and weigh their thoughts more properly. What seems just right in words can change to be doubtful in written form.

In spite of the fact that all people of this group said that there were more aspects, which did not suit for this form of studies, so if you get accustomed to this, it might turn out to be enjoyable *(Habits are changeable. That is why I think that this way of learning will suit for me.).*

5.3 Web-based learning suits well

People in different ages (age 25-45) belonged to this group. Web-based learning suited well for people, who had good computer skills before, whose attitude towards using the computer was positive and who used computer for different activities *(My everyday work and life is strongly connected with the computer, without it I don't even imagine my activity any more.)*. At the same time they felt the limitedness of the computer and the necessity of the relationships between people *(The computer is a necessary tool both in work and in communication, but it will never be more important for me than a person!).* Most of them were autodidacts, who dared to try and experiment *(If you have to learn something new, then you have to sit behind the computer and try, experiment. Try until you manage to do this...).*

During the web-based learning no one in this group had problems with time planning. They rather said that it is motivating to choose yourself a suitable time to learn *(I really like web-based learning as I am the master of my time.).* When students of the first group said that failure not to meet the date caused the feeling of backwardness and flabbiness and students of the second group felt that they need strict borders and punishment to meet a deadline, the students of this group realized that deadlines can be agreed and it is most important to plan your work the way that by the end of the course everything would be done.

Moreover, I like the way of studying if there are deadlines and workable plan and time planning is in your own hands. It was also good that activities had "silent deadlines", it means that it was important to cope with all the activities in time.

There were mainly people, who rather studied early in the morning, in the evening, or at night, who wanted to concentrate and work the material through in peace *(I Like to work through the material independently, think the material over, create schemes.),* continuously connect practice and theory and learn beside the work. They also noted that in the case of such study, they are more "in" the subject and therefore the efficiency factor might be bigger than in the case of traditional learning.

Web-based learning keeps you posted up with current topic during the whole semester, you have time to think and analyze and "be in it". In my opinion the efficiency factor of such learning is bigger than using traditional learning, at least for our kind of students who meet once in a month.

As the students of the second group, so the students of this group were conscious of constant connection with the lecturer during the course *(At the same time they had permanent connection with the supervisor.)*. Unlike the people in other groups they also pointed out the importance of associating with fellow co-students and co-operation.

During this course teamwork also improved when we had to compose forum-based seminar's instruction together (everyone had to say a word, then this "thing" was taken into account), on the occasion of the teamwork carried through in auditorium the answer sometimes begins to disperse and sometimes one person (maybe two) may do all the work.

As an interesting aspect, students of this group noted new ways of learning, which they had to learn during this course.

Therefore they tried to look for new learning strategies to cope with a new way of studying, they tried and tested how to learn the material better.

> *When the material is on the paper I usually make notes on it – draw lines; the most important ideas I write beside the paper, so that later it is possible to revise the material very quickly, etc. I did differently with this course's material – I thought that I had read from the computer. Knowledge check-up at the end of materials showed quite poor result, it means that I hadn't understood the material and I had to read it through once more – whereby now I already made notes (made a short summary). The result was already better. This is an example of changing my studying habits. I made sure that it is possible to learn differently, you just have to test different option*s.

5.4 Connection with participation activity

Analyzing with hierarchical cluster analysis student's participation activeness on courses (in WebCT-s students statistics) differed also 3 groups (look also Table 1):

- Participators with average activeness (10 people: 2 men and 8 women)
- Active participators (12 people: 2 men and 10 women)
- Very active participators (4 people, all women)

Table 1. Average group parameters, which are differed by hierarchical cluster analysis

	Number of times they have looked studying materials	**Number of times they have watched messages, posted to the forum by the others**	**Number of messages they have posted to the forum**
Participators with average activeness	326.9	146.7	14.7
Active participators	549.4	247.7	16.8
Very active participators	966.5	463.6	29.8

All the students to who web-based learning did not suit belonged to the participators with average activity. People, who found both suitable and unsuitable aspects in web-based learning, belonged to both: participators with average activity and active participators (50% of them in both groups). People who considered the web-based learning to be suitable were in all groups: in the group with average activity 17%, in the group of active participators 50% and in the group of very active participators 33%. Therefore, it can be said that more active participation on courses is generally connected to the satisfaction with web-based learning (Cramer's V= .48, p= .02).

6 Conclusions

For conclusion it could be noted, that the suitability of web-based learning is, on the basis of present research, connected to three big areas (look also Table 2):

- Computer skills, which also influence the fields of computer usage;
- Student´ s characteristics and learning skills (skills of time employment, self-discipline etc.);
- Participation in the course work.

Table 2. Resumptive description of groups

	Web-based learning does not suit	Web-based learning suits in some aspects	Web-based learning suits
Computer skills	Poor	From poor to very good	Good or very good
Computer uses	Primarily for forming written documents	Varied uses	Varied uses
Skills of time employment	Missing	Little	Good
Self-discipline	Little	Average	Good
Using WebCT opportunities (for example schedule)	Do not use	Use	Use
Motivation	Missing	Outer	Inner
Contact with lecturer	Missing	Exists	Exists
Contact with fellow students	Missing	Little	Exists
Learning strategy	Same as traditional learning	Same as traditional learning	New learning strategies
Activity of taking part in courses	Average	Active	Very active

As we see, besides these characteristics there are not such kind of areas, which person cannot change. For example: gender or age. All these characteristics are developmental. Web-based student's preparation should start already in comprehensive schools, wherein learning habits, self-discipline, co-operation skills etc. form. Comprehensive school should also give enough computer skills to school graduates that the way these would not counteract the choice of international courses offered in web-based learning environment in future.

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Technolocigal Tools in Education

Streaming Media Lectures: A High Quality but Cost Effective Distribution of Learning Content

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Streaming Media Lectures allow a high-quality and a cost effective distribution of learning content. The separate learning modules can be rearranged and offered for different study subjects or even different universities. Streaming Media gives educational institutions the chance to produce many e-learning modules at justifiable technical expense and human resources.
However, how can universities produce affordable streaming media lectures? How can face-to-face lectures be transformed into streaming media lectures? What decisions have to be made considering design and organization to utilize the technical potential of streaming media? Design guidelines are needed for the transformation of face to face lectures, for the presentation and organization of information under multimedia and hypermedia aspects and the mediation of information regarding instructional aspects. In order to find a starting point for creating the design of streaming media lectures, the transformation of previous theoretical and empirical findings from multimedia, hypermedia and instructional areas into the streaming media lectures is necessary. Furthermore, experiences from previous projects should be taken into consideration.
In the following, decisions from the research project "e-learning with streaming media lectures" at Aalen University, Germany about planning and designing will be considered. They create a frame for a learning environment with streaming media lectures.

Keywords: streaming media lecture, e-learning, streaming video, multimedia principles

1Introduction

The traditional transfer of knowledge at universities takes place in many different forms. The established types consist of lectures, seminars, exercises or tutorials, practical training, project work and colloquium. In these types, three different teaching procedures can be put in action with methodical conception: presentations, course work, and explorative teaching procedures. The differences between these teaching procedures are the stages of structuring and the stages of learning activity.

Our recent study at German Universities has shown , that in nearly 52 percent of lectures, the teachers present their knowledge while the students listen and take notes, and only ask a few questions. 29 percent of classes are in coursework style and 19 percent use explorative teaching procedures (see figure 1).

[1]We interviewed 189 lecturers by telephone or face-to-face about the teaching procedures, presentable forms (text, formula, etc.) and media devices they use for teaching students. They answered the questions for one single lecture and not for a

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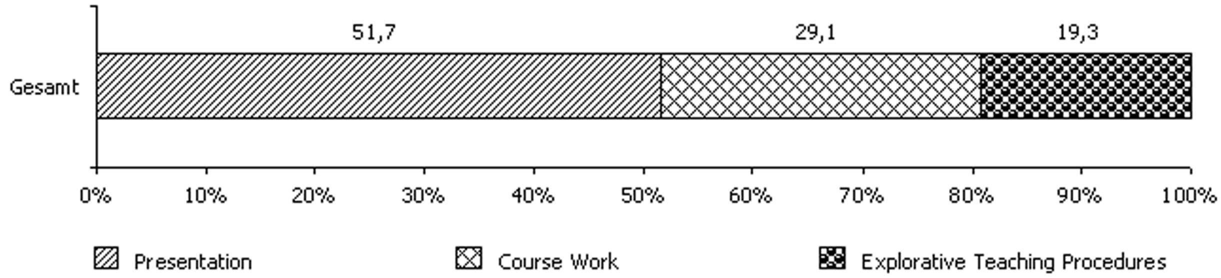


Figure 1. How common are the certain teaching procedures?

In conclusion, the most common form for instructing groups of learners is the presentation, which has been used in higher education for more than two thousand years (cf. Gagné, Briggs, & Wagner, 1988). McLeish (1976) named positive reasons for this form of instruction. The lecturer can inspire listeners in classroom lectures, forward research areas and activities to students and other interested persons and connect theory and research with practical problems.

The learning environment concept of presentation lectures includes a frontal seating order which enables the teacher to clearly see all learners. The lectures last up to 90 minutes (depending on the lecture) whereby the teacher is the centre of attention and influences the major part of the lecture. From the didactic point of view, classroom lectures correspond to the teacher-centered approach, since the teacher instructs and guides the learners verbally. The teacher is the central figure of face-to-face lectures and receives all of the students' attention. The teacher is an expert in the subject, an information giver, an organizer, an advisor, an evaluator and a role model (cf. Flechsig, 1996). The learner takes over the role of a passive observer. He reacts to the teacher's questions and occasionally poses questions or makes suggestions.

The knowledge is carried in presentable forms (media content), for example as text and formulas, but also as animations and videos. The media devices create a visualization of the information. At universities the lecturers use wipe boards and marker pens, overhead projectors or video projectors.

As figure 2 shows, teachers at German Universities present their knowledge in different ways: 45 percent use a video projector, 27 percent use an overhead projector (handwritten, copied or printed), and only 25 percent use the black- or whiteboard.

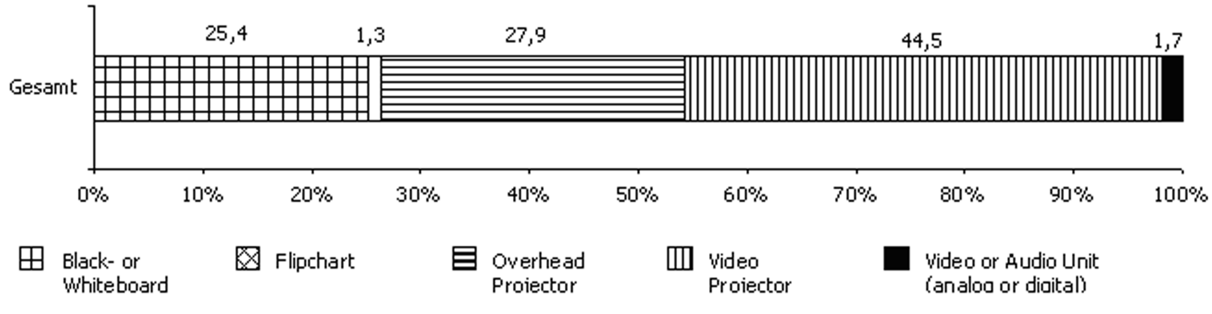


Figure 2. Which media devices do German teachers use in higher education?

Finally, over 60 percent of all presented content is already digitized, that means it is either presented with an overhead projector or with a video projector. This teaching format is the best for reformatting into a streaming media lecture.

scope of lectures that they offer. Some lecturers gave feedback for more than one of their lectures, altogether we have a sampling of 274 lectures.

2 Principles for Streaming Media Lectures

Reeves & Nass (1996) postulate in their Media Equation Theory, that a learning environment on a computer should be made as close to reality as possible, since the learners principally show the same behavior when learning with media as when learning in a traditional "real" learning environment. As a conclusion from this information, it seems recommendable to place the teacher on the left side and the presentation on the right side of the user interface in order to get as close as possible to the real environment of a face-to-face lecture. Nevertheless, this is an assumption without empirical proof, though most of the given examples lean towards this design. With a control unit and dynamic hyperlinks (table of contents),the learner is able to use the streaming media lecture interactively. Since both interactive elements relate directly to the streaming, it seems reasonable to place them underneath (cf. Dix, Finlay, Abowd, & Beale, 2004, p. 191-224).

Altogether four basic elements can be recommended for a streaming media lecture:

(a) The streaming video should follow the content of the lecture and the teacher.
(b) The presentation (slides) order should allow the students to visualize the information given by the teacher.
(c) A control unit should be in place for starting, stopping or sliding to any position of the lecture.
(d) A table of contents should be included in order to switch between the sequences or chapters of the lecture.

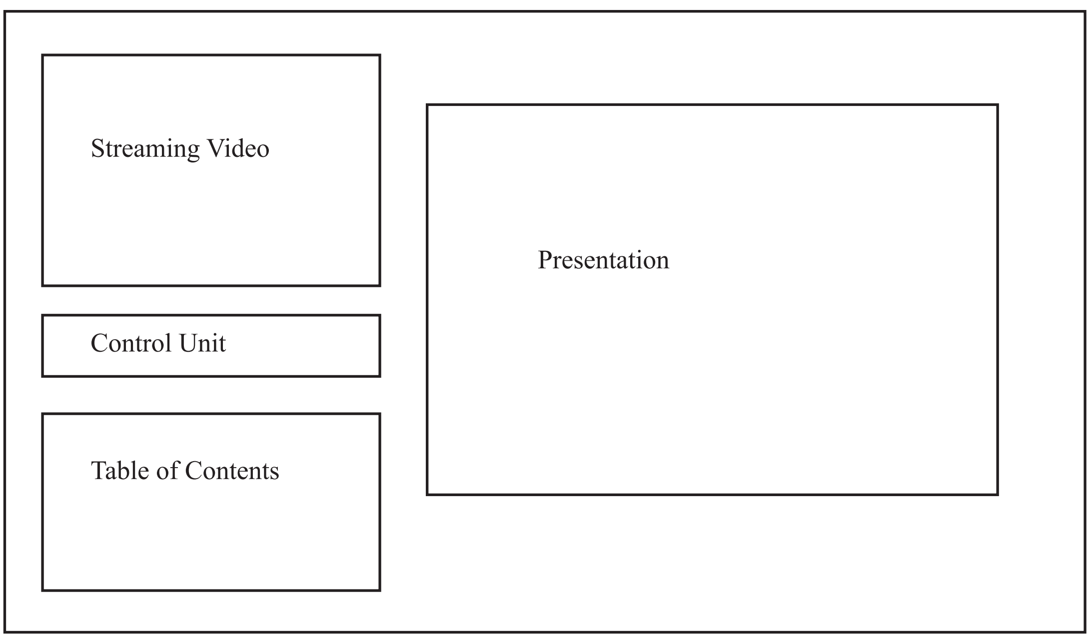


Figure 3. Design Concept for Streaming Media Lectures

Using this design concept, the learner comes across a well known environment to him. According to Reeves and Nass (1996), men have the ability to establish relationships and understand how the physical world functions. If the media adjust the social and natural rules, students do not need to be instructed by using them.

"People will automatically become experts in how computers, television, interfaces, and new media work." (Reeves & Nass, 1996, p. 8)

The proceeding development in the Internet technology allows realistic static and dynamic visualization, but does it really improve learning achievement? Already 1947, the U.S. Army (cf. Hall & Cushing, 1947) set up a research project and analyzed whether video-based instruction, text-based instruction or traditional face-to-face instruction achieves the best learning achievement. They developed three different learning modules for reading a micrometer:

1. The "film group" watched a narrative instruction for reading a micrometer.
2. The "face-to-face group" listened to and watched an instructor who presented the same lesson as in the video about using a micrometer.
3. The "text group" read a text including the spoken word of the film and pictures. The pictures contained arrows to show the movements.

After this, all did the same test. However, Hall and Cushing could not recognize any differences in the learning achievements. Over the last 50 years, more studies could not confirm that dynamic media either enhances the learning achievement or reduces it (cf. Clark, 1994; Dillon & Gabbard, 1998). According to Mayer (2002), not the media influences the learner achievement, but rather the method of instruction. Fey's (2002) research has shown that students always preferred audio-visual presentations instead of only auditory presentations. However, she could not prove a significant difference in learning achievement between those two types. Glowalla (2004) confirmed her results with his studies. His students additionally meant that in comparison to face-to-face presentation, they could better concentrate on audio-visual presentations. Auditory presentations they felt as too boring. In audio-visual presentations the students were extremely motivated. However, whether audio-visual presentations allows a more sustainable learning should be researched throughout long-term studies.

2.1 Elementary Design Principles for Multimedia

Streaming media lectures represent a multimedia environment, where information in the form of audio or video text is combined with pictures, charts, tables and so forth (cf. Astleitner, 2002). The audio/video sequences are linear. Mayer and his colleagues (cf. Clark & Mayer, 2003; Mayer, 2001; Mayer & Moreno, 1998; Moreno & Mayer, 2000) formed empirically proven design criteria for video or animation sequences, which are based upon research in cognitive psychological fields (cf. Jans, 2005, pp.73-88). The following basic principles can be concluded from the theories for the multimedia design of streaming media lectures.

(a) Presenting streaming media lectures in combination with audio/video pictures of the teacher aligned with a presentation of the lecture's content is more effective than an audio/video picture of the teacher alone. Therefore, it does not seem appropriate to transform and offer a face-to-face lecture without any additional presentation of the content. (Multimedia Principle)

(b) The presentation of the video picture with the teacher and the slides with the lecture's content should be arranged in a manner that the learner can absorb both sources of information at the same time. He should not be forced to split up his attention between the two media contents. Therefore, the information on the slides should not be too complex and the design should not be too extravagant. This ensures that the learner can pick and process information before the next slide comes up without loosing track of the lecturer's presentation in the video picture. When designing the video sequences, the design proposals in section 2.2 could be helpful. These include slower camera movements, homogeneous design of the background in order not to overload the learner with new attention catchers. Furthermore, side noises in the audio signal should be avoided. (Split-Attention Principle)

(c) As a matter of principle, a verbal (audio) explanation of the visual content presentation (slides) is often better than explaining it through additional text on the screen. Graphics or pictures should, therefore, not be explained with additional text, but by the teacher. This is particularly important in the case of fast switches of slides. This is especially true for a simultaneous presentation of text and graphics in a slide, not so much for text itself. The text in the slides should conform with the spoken words of the teacher, and only key words should be used for text in the slides. Alternatively, the slides should provide an illustration while an accompanying voice provides explanation. (Modality Principle)

(d) When explaining the content of slides, the teacher should not present both the words as narration (verbal) and the identical text as a graphic (visual) at the same point in time. If graphics are presented in the slides, they should be explained by the teacher and not through onscreen text that duplicates the audio (sub-titles). An exception could be made if the teacher gives the learner enough time to view, read and understand the information or if there is no pictorial presentation. This exception is also acceptable for the case where it might be easier for the learner to read an explanation instead of listening to it. This could be a fact when the lecture is not held in the mother tongue of the learner. If working in a second language, there is a strong case for providing the spoken words as sub-titles. An expensive post-production could even provide sub-titles in foreign languages. This is also an important issue for hearing-impaired users. (Redundancy Principle)

(e) All elements of a streaming media lecture should be integrated in one and the same user surface. Presenting them in additional windows is not recommended. (Spatial Contiguity Principle)

(f) The verbal and visual information should be temporally synchronized rather than separated in time. This means that the spoken word, or rather the visual action of the teacher (audio/video picture), should be temporally synchronized with the presented information (slide). (Temporal Contiguity Principle)

(g) In the streaming media lecture only relevant information should be integrated in the form of pictures and sound. Irrelevant information in content presentations (e.g. irrelevant graphs in slides) and in the user surface of the streaming media lecture should be avoided. This also includes irrelevant internal (on the sound track) and external (noises within the room) noises. Additional explanations by the teacher that do not directly relate to the content of the presentation should be avoided as well (cf. Mayer, Bove, Bryman, Mars, & Tapangco, 1996). (Coherence Principle)

(h) The teacher should communicate the information in the lectures in a personal, friendly and informal manner (cf. Reeves & Nass, 1996). In order to achieve this, the teacher should feel comfortable when the lectures are filmed and behave as naturally and authentically as possible. (Personalization Principle)

(i) The learner should be able to affect and control the streaming media lecture. Therefore, the surface of the streaming media lecture should include control units and dynamic hyperlinks (table of contents) which ensure temporary and interactive control and access to the sequences. (Interactivity Principle)

(j) The teacher should try to influence the attention of the learner by accentuating especially important facts. Such information could additionally be enhanced in the slides through separate coloring with signaling colors. The accentuation of spoken and written words can be synchronized in order to strengthen the desired effect. (Signaling Principle)

Since the principles are empirically founded, considering them will help the learner to better understand the multimedia presentation of streaming media lectures. Therefore, all the basic elements are integrated in the user interface (spatial contiguity principle). The streaming media lectures are furthermore integrated in an e-learning environment, which should be clearly separated. Integrating the streaming media lecture in an e-learning environment offers the learner additional functions through several links. The learner can choose several feedback possibilities via the link "communication", which include e-mail, discussion groups, chats or a white board.

In order to keep the attention of the learner during the lecture, both sources of information, the video picture of the teacher (streaming video) and the slides, are presented in a non-complex design (split-attention principle). Furthermore, the slides are synchronized with the spoken words of the teacher. The switch between the slides in the streaming media lecture is connected to the movement of the teacher toward the notebook in the streaming video. The content of the slides is reduced to the essential facts and contain key words which only explain the graphics. They are explained in detail by the teacher (modality principle). Basically, the content on the slides is not strictly repeated by the teacher, but present a summary of the lecture (redundancy principle). If there is an especially important fact to be underlined, the words are colored red at the moment of mentioning (signaling principle). Since the teacher shall present the lecture in the most authentic way possible, students have been integrated in the filming of the lecture (personalization principle).

In order to avoid irrelevant audio information, the students have been asked not to pose questions during the filming process (coherence principle).

The learner can control the streaming media lecture through the control units by using start, stop and pause buttons, as well as through a table of contents (interactivity principle). The control units are limited to only essential buttons. The learner cannot time line, fast forward or rewind the lectures, since time lags might occur during the internet data processing by the streaming technology. The omission of these control units does not seem to be unreasonable. This again influences the satisfaction of the learner and thereby supports the learner's motivation. It is clear that the multimedia and film design are connected with each other and, therefore, the principles should be applied before and during the filming process of the teacher.

2.2 Principles for Recording Streaming Media Video

Lectures in higher education commonly last up to 90 minutes. The teacher normally walks around and talks to the students, and maybe the teacher or the students ask questions. Of course, such a lecture can be just recorded and streamed. It would be useful for students who missed the class, or for student's revision. However, is it useful to replace a traditional lecture (presentation) with a Streaming Media Lecture? For several reasons we recommend recording Streaming Media Lectures separately. First of all, in a traditional lecture, teachers use a combination of media devices and would walk around. The cameraman would need to "catch" the teacher. Secondly, students would talk during the lecture. Since audio is more important than video in streaming media lectures, it is recommended not to have any background sounds. Thirdly, the communication between the teacher and the students is not easy to record. A learner participating in a Streaming Media Lecture might feel that he is missing out on a part of lecture. This could influence the learning achievement. That being the case, we recommend the following rules for video recording, audio recording, and lecture unitising.

(a) Video Recording

Camera Position: The camera should be positioned to ensure that the teacher stands in relation to the slides, which are later added in the user surface of the streaming media lecture (cf. e.g. Wetzel, Radtke, & Stern, 1994). The teacher should, therefore, look in the direction of the later added slides. It could be helpful to place a notebook next to the teacher while filming, which will then lead the view of the teacher in the preferred direction. Additionally, it might be helpful for the teacher to sit some students next to the camera. The teacher will automatically look into the camera.

Zoom and Panning: Zoom or movements of the camera should be avoided as much as possible and if necessary, the movements should be made very slow. The following compression of the video sequences can easily result in movements appearing as bucking pictures (cf. e.g. Wetzel et al., 1994). By placing the teacher's desk and a notebook for the teacher, the movement radius of the teacher is already limited and camera movements are avoided.

Camera Detail: The teacher should be as big as possible in the final video (close-up view). This is necessary, since the video picture will later on be scaled down in order to ensure its integration into the user surface. Otherwise, the teacher's facial expression would be difficult to see.

Light: The light should be set up in such a way that the subject (teacher) is entirely illuminated and without shadows (cf. e.g. Wetzel et al., 1994, p. 123). This is especially important, since otherwise the quality of the video will deteriorate after being compressed (cf. Jans, 2005, pp. 29-52).

Background: The background should be homogeneous and fit into the multimedia design of the streaming media lectures. This includes the adaptation of colors, as well as the removal of disturbing items. In this context, it has to be considered, that colors also evoke emotions. (cf. Holzinger, 2001, p.123; Wetzel et al., 1994, p.124).

Clothes of the Teacher: The clothes of the teacher should also fit harmonically into the overall picture of video and user surface. Small stripes or checkered clothes cause a flickering in the streaming video.

(b) Audio Recording

When recording the spoken words of the teacher, it is important to have the best quality audio recording without disturbing noises (cf. Holzinger, 2001, p.148ff; Niegemann, 2004, p.125ff). A Streaming Media Lecture cannot be viewed without sound; on the other hand one could listen to it without seeing the video sequence. When streaming data are transmitted, the audio signal is preferred. If there is a bottleneck while transmitting the data, the transmission of the video suffers before the audio signal is affected.

(c) Filming Sequences

Filming a sequence, especially in a studio environment, should not take longer than 15 to 20 minutes. Otherwise the teacher will lack concentration, which results in mistakes in speaking and unwanted breaks. The quality of the presentation would suffer from this, as well as the transmission of the learning content. Furthermore, it can be said, that the teacher behaves differently when speaking in front of a camera than in front of a class. This might result from the fact that the filmed sequence is used to conserve the spoken word. If the sequence or lecture is filmed in a usual classroom environment, the behavior of the teacher is more similar to a normal face to face lecture.

3 Production line for Streaming Media Lectures

Since 2001, the Media Centre of Aalen University has produced over 180 Streaming Media Lecture of over 20 different teachers. Students can watch those lectures from any place in the world. Basically, the production line can be divided into seven steps:

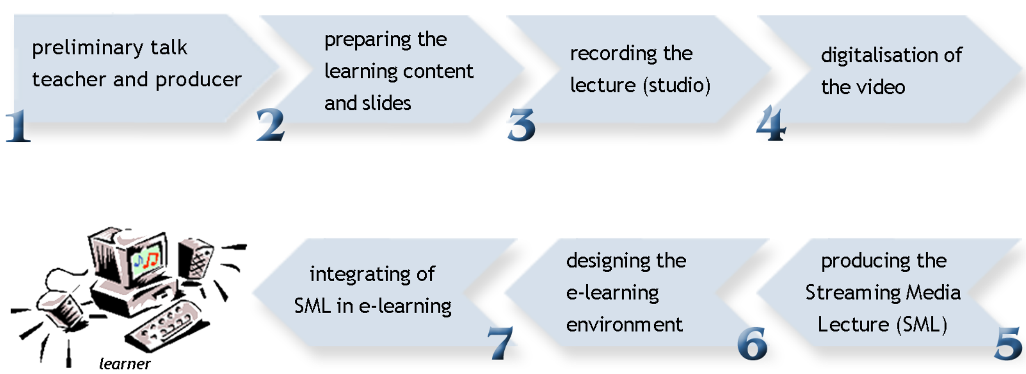


Figure 4. Production line of Streaming Media Lectures at University Aalen

1.Preliminary talk (producer and lecturer)

> The lecturer and the producer talk through the lecture and divide it into 15 or 20 minute modules.
> The producer and the teacher should arrange the modules so that they can be rearranged differently and can be used in other study subjects. For example, Aalen University has produced several modules on the basics of marketing for the international business students and today they are also used for optician students.
> The lecturer receives a presentation master and a style guide.

2. Optimizing the presentation (producer or student assistant)

The producer or a student assistant receives the presentation before the lecture will be recorded. They check over every presentation slide for graphical aspects, such as the arrangement to text and pictures and the readability. As the case may be, they optimize the slide (Microsoft Powerpoint).

3. Recording of lectures (producer, lecturer and students)

The producer records the modules (15 to 20 minutes) in the studio, up to a maximum of four hours per day. Mostly, two or three lecturers share one recording day and lecture in turn.

4. Digitizing videos (producer or student assistant)

After the videotaping, student assistants digitize and cut the video, which will be saved as a Microsoft DV AVI (Adobe Premiere Pro).

5. Combing and publishing video with presentation: Streaming Media Lecture (producer or student assistant)

With special authoring software for streaming media, the video will be combined with the slides. Additionally some text objects, such as the name of the lecturer and of the module, and dynamic hyperlinks optimize the learning conditions for the students.

Those produced streaming media lectures cannot just be published on the Internet. The students need a learning environment which includes more than just content. Every learning module needs a learning goal, printed scripts, a printed presentation for taking notes, further literature, and a duration time. Some teachers even offer self-tests, which helps the learner to control their learning achievements. Additionally, the e-learning-modules need to be integrated into the whole learning experience, so the students will definitely need a learning concept so they will know what happens in face-to-face-sessions, and what to do during the online session. They need a timetable and communication tools.

Therefore, two steps need to be added to the production line:

6. Conception of the E-Learning-Course

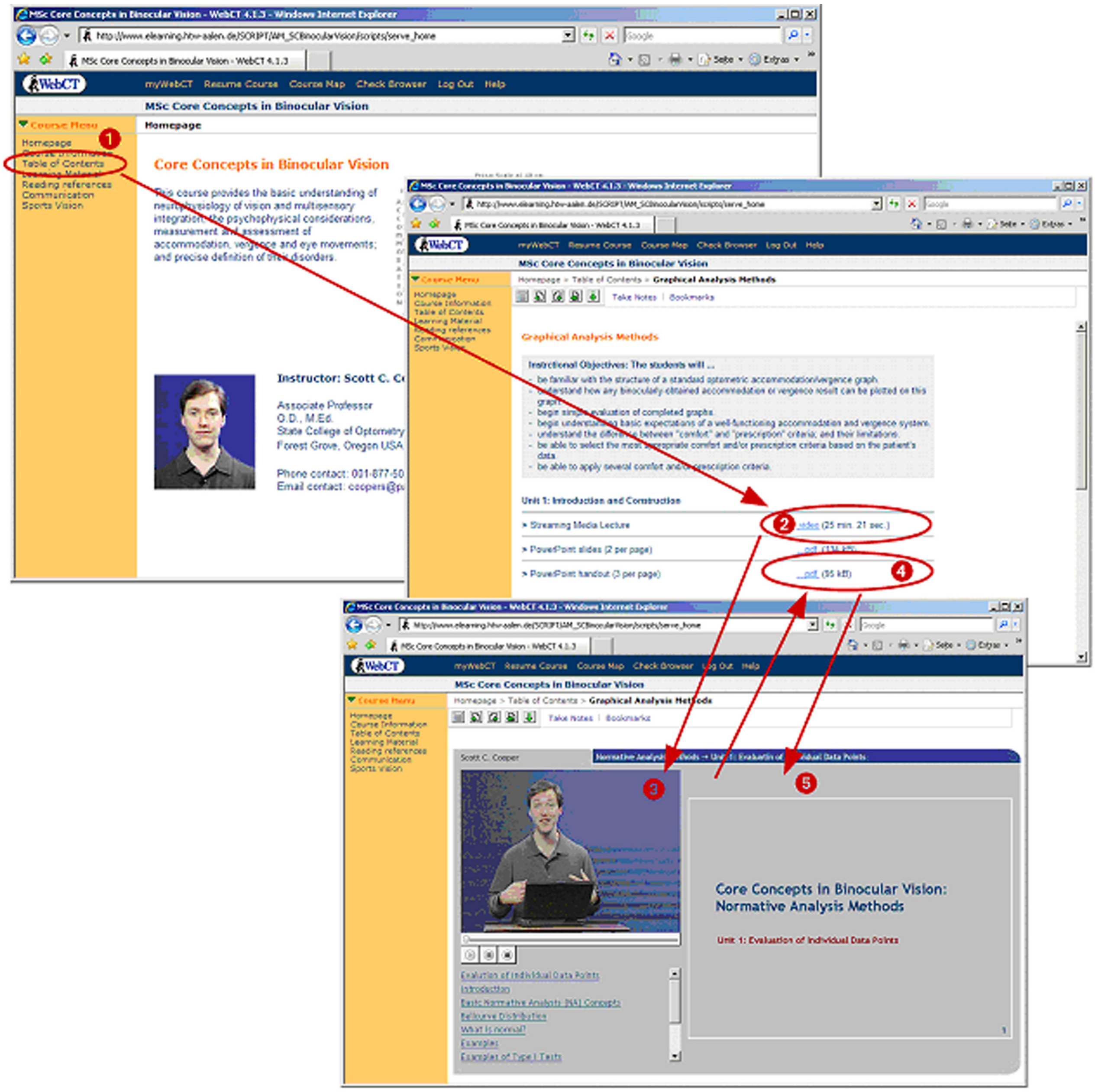
In the learning environment (WebCT) the producer creates a course for the teacher with the following tools:
- Lecture Theme
- General Course Information (time table with face-to-face-sessions and online-session, list of teacher(s), tutor(s) and students)
- Syllabus (learning content and learning goals)
- Table of Contents
  Every learning module consists of a learning goal, further literature, a presentation (manuscript for taking notes), and the duration time for learning this module.

7. Final Check and Release of the course

The teacher checks the whole course; after this, the course is released to the students. The learning environment offers many more tools, for example for communication, group work, self tests, and tasks. The Media Centre of Aalen University offers tutorials and classes for lecturers who want to broaden their online range.

Figure 5 shows the graphical user interface, which the students receive by logging in to WebCT. First of all, they find their course list. After they have chosen which course to study, they find a short course overview. In the table of contents

(1), they choose one unit (2). Our studies have shown that the students first watch the complete video once (3). After that, they print the presentation (4), go back to the video (5), and watch it step by step while taking notes (cf. Jans, 2005).



For Aalen University and its research projects has it always been very important, whether E-Learning is affordable for educational institutions and whether it is possible to convert produce an appreciable amount of lectures into E-Learning. The last six years has shown that we can reach a production rate from 1:10 down to 1:3. That means: for one hour streaming-media-content we only need three to ten production time (step one until five).

This production rate can only be realized …

– … if a production facility for recording streaming media lectures is available.
– … if a streaming media server (real or windows media server) and an e-learning-environment is at hand.
– … if the teacher use the given templates for the presentation.
– … if the teacher stands to the agreements of the preliminary talk and is well prepared for the recording.
– … if the University does not produce the Streaming Media Lecture on-by-one, but rather offers a production week.

The Media Centre of Aalen University produced ninety different single modules for Master in Vision Science and Business. The teaches are from Aalen University, but also from Pacific University (Forest Grove, Oregon, USA) and New England College of Optometry (Boston, Massachusetts, USA). Streaming Media allows offering the students competence from all over the world.

Today teachers at Aalen University have the opportunity to record their lectures regularly. The production team consists not only of assistants, but also students help to produce new streaming media content and to advance to whole process.

4 Conclusion

The Paper describes the necessary planning and design decisions to be able to transform a face-to-face lecture to a streaming media lecture. Design decisions must be made for recording the film sequences, for the multimedia presentation of information and the hypermedia organization of information. These principles have to be considered so that the streaming media lectures meet the cognitive as well as the instructional standards. There is no such thing as the golden mean. Decisions must always be made with regard to the application of the streaming media lecture. The learner and his individual competences and technical requirements must always be taken into consideration for all design decisions. So far, the examination of the streaming media lectures has been largely isolated and the focus was on the medium as such. Streaming media lectures have to be integrated in a learning environment and must be combined with other didactical media and methods in order to have their full effect (cf. Jans, 2005, pp.53-72). This requires creating a learning environment that makes interplay of different media and methods in a socio-cultural context (cf. Bremer, 2001; Kerres, 2001, p. 33). In this learning environment, the learners can control their learning process largely themselves and adapt it to their needs and experiences.

Further project information you will achieve under: http://www.medienzentrum.htw-aalen.de/streaming/

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Mentor – a Knowledge Management System Supporting Teachers in their Leadership

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The goal for knowledge management is to create the knowledge that drives the organisation forward and provides a professional community. One of the biggest challenges for knowledge management in educational organisations is to move toward a more student-centered learning environment. According to the constructivism deep learning and critical thinking can be achieved if the students are active in the learning process, which mainly takes place in a student-oriented setting. A reasonable assumption is that in student-centered schools the teachers' teaching strategies and, at the same time, their role as a leader is of great importance. For instance, a more democratic than autocratic style is emphasized. Therefore, it is important for knowledge management within educational organisations to deal with the task to support the teachers to take such a democratic role. Information and Communication Technology (ICT) in form of knowledge systems can be utilised in this process. In this article we present the design of a prototype, called Mentor, with the aim to give the educators the opportunity to reflect on their current teaching strategies and get guidance how to improve their teaching, which in turn can influence their leadership in the classroom. Bloom's revised taxonomy has been utilised to relate the teachers' answers, regarding their teaching strategies, to the taxonomy and also to give different kinds of feedback based on the educational objectives in the taxonomy. Mentor may support all the phases within knowledge management; capturing, sharing, applying and creating knowledge.

Keywords: Knowledge management, teachers' leadership, Blooms revised taxonomy, computer-based teacher support, knowledge systems.

1 Introduction

"The last decade has seen the birth of a new science – knowledge management" (Housel & Bell, 2001). Knowledge management, KM, can be defined as management of organisational knowledge for creating business value and generating a competitive advantage (Tiwana, 2000). Usually, when speaking about KM the aim is to increase companies' profit. But KM can also be applied in organisations where profit is of no interest, which may be the case for, e.g., schools. The purpose with KM in the school organisation can be to facilitate the students' learning, increase the parents' participation, and support the teachers (Edman, 2005).

The companies' value is no longer the equipment, buildings, or receivables, but instead the intellectual capital (Housel & Bell, 2001)) and educational organisations are no exception. Knowledge management involves people, organisational processes, and technology in overlapping parts (Awad & Ghaziri, 2004). Thus, the intellectual capital, i.e. the people and the organisational processes, can be supported by ICT.

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In schools, the traditional role of the teacher primarily as a tutor, can be challenged by seeing the teacher more as a leader of an educational team, where the teacher's leadership capacity is just as important as the pedagogical skill. Teacher leadership is important for, e.g., creating school environments where students perform well and where each student is known and treated as an individual (Usdan, 2001).

Educational technology has been consecrated to develop discoveries using theory and practice to create, facilitate, manage, utilise, and assess the methods of teaching and learning. The consequence is that teachers can get insight into new teaching and learning techniques (Kerka, 1994). By offering educational technology the way of managing knowledge in the educational organisations, and also the teachers' leadership, may be changed and improved.

Knowledge management in an educational organisation involves a principal, administrative staff, teachers and students. The goal in such organisations is to offer an environment where the students can learn and in this the teachers play an essential role. Therefore, we have chosen to put the focus on teachers by designing a knowledge system, named Mentor (introduced in section 3), in order to improve the process of teaching and thereby also improve the knowledge management of the educational organisation. The improved quality of teaching can be assessed in terms of increased deep learning and the students' improved capability to think critically. Teacher leadership deals with strengthening student performance and working towards collaboration, which can result in a professional community among the students (Usdan et al, 2001). Thus, the teachers' leadership style applied in the classroom has a significant impact on students' development and the movement should be towards a student-centered approach.

Bloom's revised taxonomy can be utilised for a classification of different objectives and skills that educators need to reflect upon in the learning environment. According to the revised Bloom's taxonomy deep learning requires a higher order of cognitive thinking skills, such as analysis and creating new knowledge, where the students must be able to integrate components in a holistic way (Anderson & Karthwohl, 2001). In Mentor the taxonomy is utilised to relate the teachers' answers, regarding their teaching strategies, to the taxonomy. And also, the system will use the taxonomy as a basis for the feedback generated to the teacher. This feedback is related to the answers the teacher has given concerning his/her teaching. Through discussions with pedagogues the mapping between the answers and Bloom's revised taxonomy is elaborated and the work with the implementation in Mentor is ongoing.

The paper is structured as follows. First we give some remarks regarding learning and the revised Bloom's taxonomy is introduced. Then a presentation of the Mentor system with the purpose to support teachers in their tutoring is given followed by an overview of the architecture. This is followed by a discussion regarding knowledge management in an educational organisation. A concluding discussion and further work will complete the paper.

2 Learning and Bloom's revised taxonomy

Studies show that both students and teachers have different perspectives on how to learn and what to teach (Hedin, 2006). When the goal is to mediate facts, teaching will be concentrated mainly on presenting the facts within the subject and students are required to pay attention and listen carefully so they will be able to memorize and reproduce what has been said. To achieve deep understanding the students are engaged in a variety of learning activities. As they move and progress to deeper levels they have to be more active, see Figure 1. There is a problem, though, if there is a mismatch between the student's and the teacher's goal.

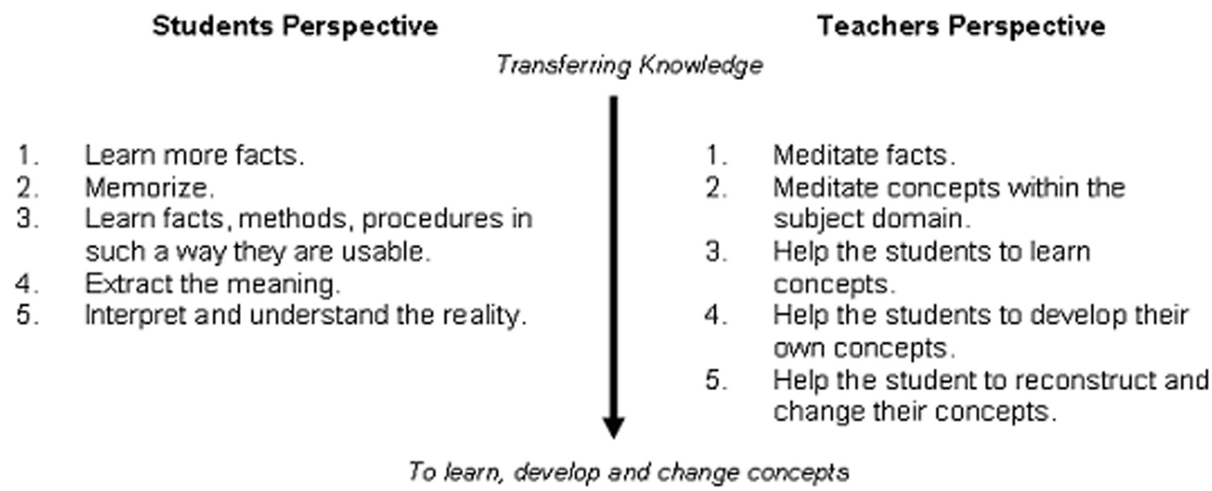


Figure 1. Students' and teachers' view of learning (Hedin, 2006)

There are two main strategies for learning; deep and ground (Marton et al, 1996). In a ground approach to learning the students focus on memorizing sets of facts, reproducing parts of the content and thereby developing an atomic view. The deep approach to learning takes place when the students focus on significant issues in a particular topic and reflect on what they have read, relating their own previous knowledge to the new knowledge they have obtained. Deep learning is consonant with constructivism. The constructivist approach to learning dominates learning theory today (Morphew, 2002). Constructivists view knowledge as something that a learner actively constructs in a knowledge-building process, piece by piece.

Bloom's revised taxonomy is used to classify different objectives and skills that educators need to reflect upon to support students' deep learning (Anderson and Krathwohl, 2001). In 1956 Benjamin Bloom led a group of researcher to develop a way of classifying different knowledge levels.. Bloom identified six levels of cognitive processes. The first and the simplest level is "knowledge", which involves recognizing and reproducing facts. Then the level complexity increases up to "create level" meaning that students can evaluate, criticize and give recommendations, see Table 1. Their research showed that 95% of questions in examinations were answered by students at the lowest level, namely the "knowledge" level, which essentially means that they were just remembering facts

Table 1 Blooms revised taxonomy (based on Anderson & Krathwohl 2001)

		The cognitive process dimension					
		1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
The knowledge dimension	A. Factual Knowledge						
	B. Conceptual Knowledge						
	C. Procedural Knowledge						
	D. Meta-cognitive knowledge						

Anderson and Krathwohl (2001) revised Bloom's original taxonomy by combining the cognitive process and the knowledge dimensions. The revised taxonomy incorporates both the kind of knowledge to be learned (knowledge dimension) and the process used to learn (cognitive process dimension). Both dimensions can be used to help write clear, focused objectives, see Table 2 and Table 3.

Table 2. The knowledge dimension.

Factual Knowledge	Knowledge of discrete, isolated, content elements bits of information. It includes knowledge of terminology and knowledge of specific details and elements.
Coceptual Knowledge	Knowledge of a more complex, organized knowledge forms. It includes knowledge of classification and categories, principles and generalizations, and theories, models and structures.
Procedural Knowledge	Knowledge of how to do something. It includes knowledge of skills and algorithms, techniques and methods, as well as knowledge of the criteria used to determine and or justify when to do what within specific domains and disciplines.
Meta-cognitive Knowledge	Knowledge about cognition in general as well as awareness of and knowledge about one's own cognition. It encompasses strategic knowledge, knowledge about cognitive tasks, including contextual and conditional knowledge and self-knowledge.

Table 3. The cognitive process dimension.

Remember	means to retrieve knowledge from long-term memory.
Understand	is defined as constructing the meaning of instructional messages, including oral, written, and graphic communication.
Apply	means carrying out or using a procedure in a given situation.
Analyze	is breaking material into its constituent parts and determining how the parts related to one another as well as to an overall structure or purpose.
Evaluate	means making judgments based on criteria and or standards.
Create	is putting elements together to form a novel, coherent whole or to make an original product.

The revised version of Blooms taxonomy is used as a framework in different contexts. For instance, Athanassiou and McNett (2003) have described the development and evaluation of a meta-cognitive framework based on Bloom's taxonomy. They argue that the taxonomy has been of significant use to develop the students' critical thinking and creative skills and also their ability to get engaged in the learning activity and take the responsibility for their own learning. Moreover, they state that "the use of the taxonomy has helped our classrooms become more student-centered, as it helps our students gain increased awareness and control of their own cognitive development. In doing so, it addresses that frustrating problem so familiar to most learners: how to figure out what it is one does not know".

1 http://www.tech.port.ac.uk/~kingt/research/lough/CAA01.html

King and Duke-Williams have utilised the revised Bloom's taxonomy in a computer-based system for teachers to assist in the assessment of higher level learning outcomes. The taxonomy is used for a careful design of objective questions. Their reason for using the taxonomy is that it offers, "sufficiently detailed categories to allow outcomes to be mapped clearly onto learning activities" (ibid). The involved students were very positive and the authors stated that these questions were suitable for formative assessment regarding higher level of learning.

We will not use the revised Bloom's taxonomy to support students, as Athanassiou and McNett, neither to develop examination, as King and Duke-Williams. Our motivation for utilizing the taxonomy in the support system Mentor is firstly that to relate the teachers' answers, regarding their teaching strategies, to the taxonomy. Secondly, the teachers can get different kinds of feedback based on the educational objectives in the taxonomy.

3 The design of Mentor - a knowledge system supporting teachers

Teachers, who are trying to integrate and use new teaching methods, differing from traditional ones, are often confronted by their colleagues as well as by students (Hedin, 2006). This was a result found in a study at Uppsala University, Sweden, where 3473 students and 786 teachers answered enquiries related to the education and 140 groups of students and teachers discussed pedagogical matters. An obstacle to try new teaching methods could be the teachers' insecurity about the methods and the outcome of using them. Therefore, we mean that offering teachers the opportunity to get an insight into different approaches to teaching, without any fear for resistance, is valuable for improving the teaching quality. According to Usdan et al there is an extremely strong relation between students' learning and the quality of the teachers (2001).

In this section we present the design of the knowledge system Mentor. In order to motivate the teacher, the system starts with a brief presentation of the main ideas with using the system. Then the user will be given a set of multiple choice questions related to teaching methods. Every answer will be interpreted and mapped to the revised Bloom's taxonomy. When the user has finished a session the system will present an overview of how the answers have been evaluated according to the taxonomy. Through this presentation the user can get an insight into their teaching method, which hopefully will lead to personal reflections. Additionally, feedback will be generated upon user's request. Two kinds of feedback can be presented. The first one is dynamically generated in relation to the user's result and the other one is general and explains different objectives in the taxonomy and also gives suggestions about teaching.

3.1 Evaluating teaching strategy

At UCIrvine Instructional Resources Center' s website , one has a set of eighteen questions regarding design of courses. The set is adapted from an article by K.T. Brinko, published in "The Teaching Professor", February 1991. After discussions with pedagogues we decided to utilise UCIrvine's questions in our support system. In Table 4 are the first nine questions listed. In Figure 2 one of the questions is given with different alternatives and the chosen alternatives are ticked off.

Some of these alternatives may have follow-up questions for further classification of, e.g., exams and projects. For the sake of simplicity no such questions are included in the example.

http://www.irc.uci.edu/TRG/Preparing_To_Teach/Planning/designing_questions.htm

Table 4. A set of questions regarding design of courses[2].

1.	What are my course goals? What do I want my students to learn primarily?
2.	At what level(s) do I want my students to perform?
3.	What class activities will help my students meet these goals and levels?
4.	How will I support my students in their efforts to meet these goals and levels?
5.	What assignments will I use to evaluate my students' success with these goals?
6.	How much uniformity of assignments will best serve my students' needs?
7.	What evaluation approach will best help my students to meet these goals and levels?
8.	What evaluation unit for each assignment is consonant with these goals and levels
9.	What type of class atmosphere will foster students' success?

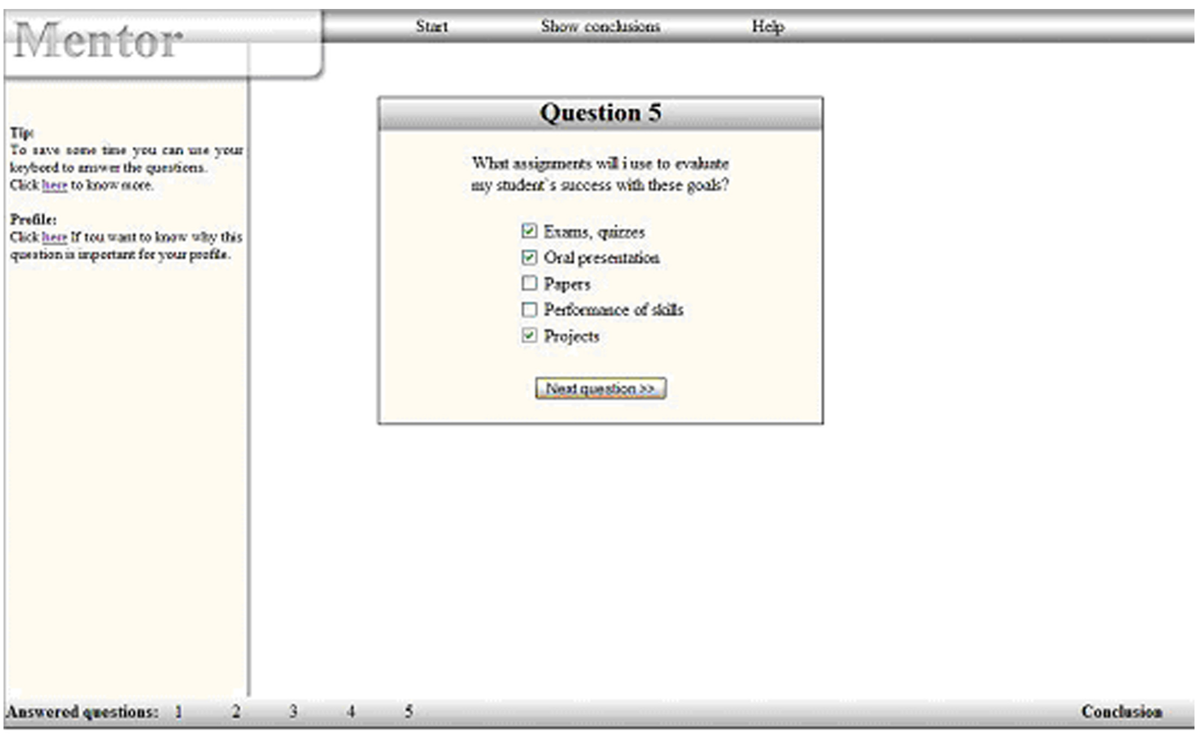
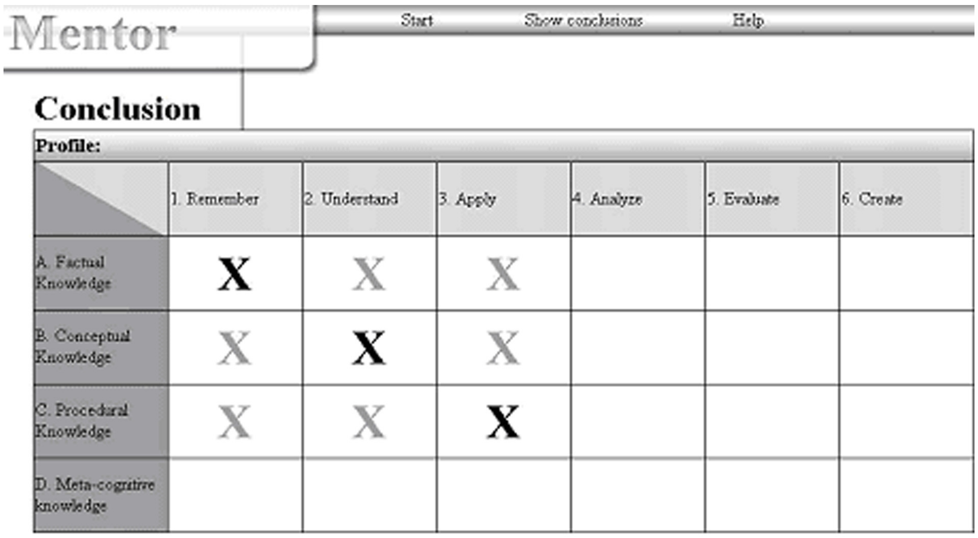


Figure 2. Anwers to question 5

The system interprets and maps the user's answers to the taxonomy and the corresponding locations are marked, see Figure 3. Let us study a possible outcome of, e.g., question 5 presented in Table 4. Often exams and quizzes assess the degree of "remembering factual knowledge", i.e. the mark X in slot A1 in Figure 3. Oral presentations, on the other hand, lead to "understanding conceptual knowledge" (B2). But to be able to perform an oral presentation you have to "remember factual knowledge" (A1) and "remember conceptual knowledge" (A2), and "understand factual knowledge" (B1). Thus, a mark in one square means that all squares above and to the left are satisfied too.

[2] http://www.irc.uci.edu/TRG/Preparing_To_Teach/Planning/designing_questions.htm

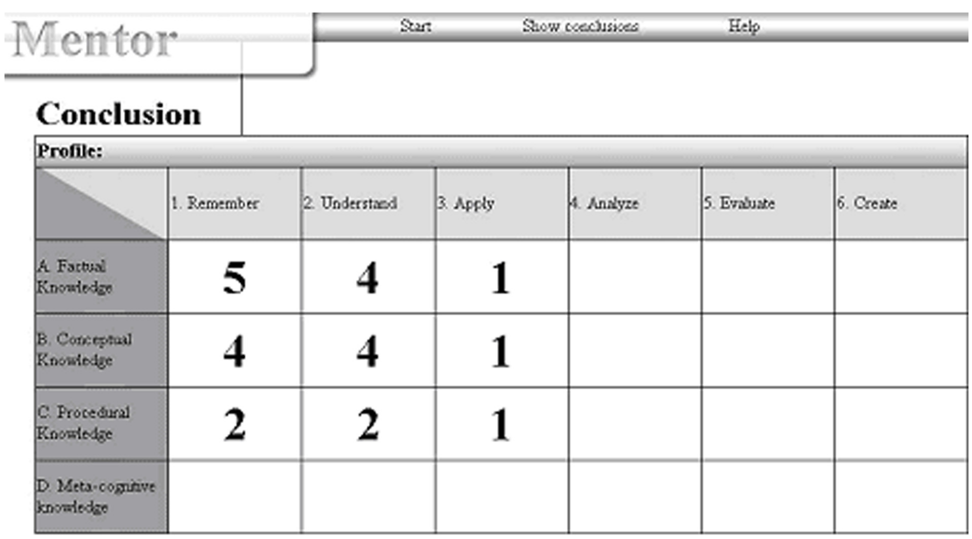


	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A. Factual Knowledge	X	X	X			
B. Conceptual Knowledge	X	X	X			
C. Procedural Knowledge	X	X	X			
D. Meta-cognitive knowledge						

Figure 3. Blooms taxonomy after mapping the answers.

Projects may result in a mark in C3 or C5, but also in D4, D5, and D6 depending on the type of project. The type is related to, e.g., the goal of the project, the level of description, demands on the documentation and oral presentation. Suppose that, in this case, the project is small, well-described without any oral presentations and the goal is to acquire "application of procedural knowledge" (C3).

When the teacher has answered all questions Mentor presents an interpretation of these in relation to the taxonomy by giving the number of matches in every square, see Figure 4. The actual outcome is utilised for the generation of feedback to the user and the different types are presented in the next subsection.



	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A. Factual Knowledge	5	4	1			
B. Conceptual Knowledge	4	4	1			
C. Procedural Knowledge	2	2	1			
D. Meta-cognitive knowledge						

Figure 4. Blooms taxonomy with number of matches.

3.2 Generating feedback

Two kinds of feedback can be presented. The first one is dynamically generated in relation to the user's result. The other one is static and explains different objectives in the taxonomy and gives suggestions about teaching when the user asks for this.

Example of a dynamically generated feedback is why there are marks in a square. In Figure 5 such an explanation is presented in relation to "applying procedural knowledge" (C3). The taxonomy can be explained, based on general knowledge and this is static. Examples are presentation of a concept, e.g. conceptual knowledge seen in Figure 6, and presentation of a square in the taxonomy, e.g. D5, see Figure 7.

Moreover, the user can investigate how he/she can change the teaching strategies to get a mark in a chosen square in the taxonomy. The tip has to be in relation to a special question and is also static information. In Figure 8 a proposal is given regarding how to reach D5 for a follow-up question related to projects in question 5 (in Table 4).

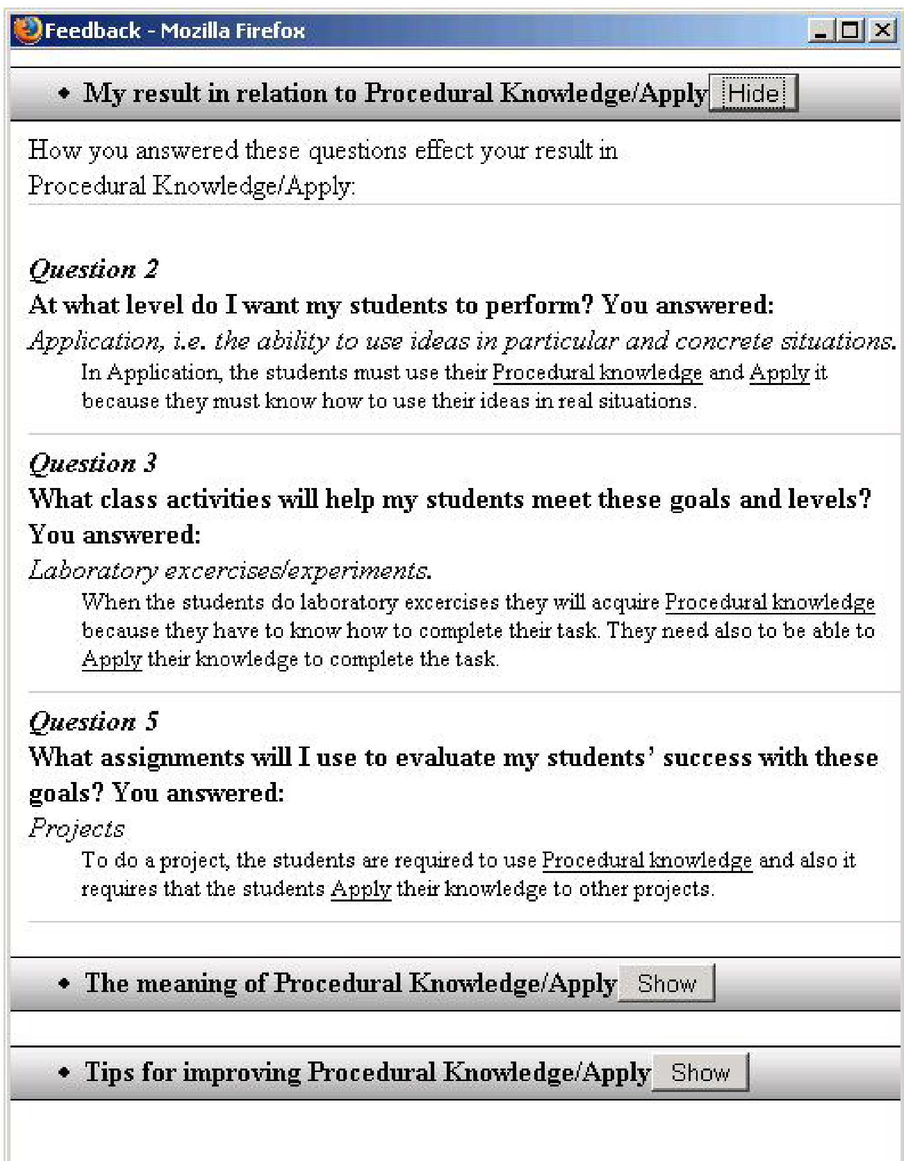


Figure 5. Explanation of why Mentor has marked C3 in relation to answers to different questions.

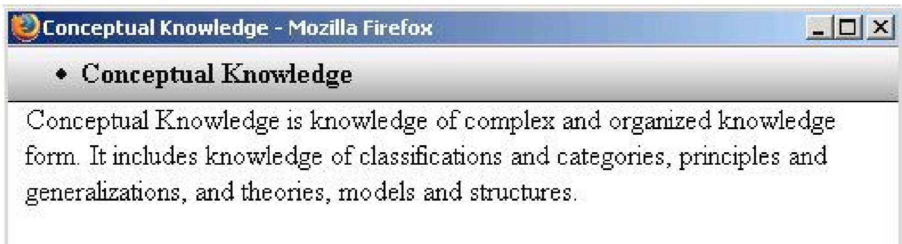


Figure 6. An explanation of conceptual knowledge.

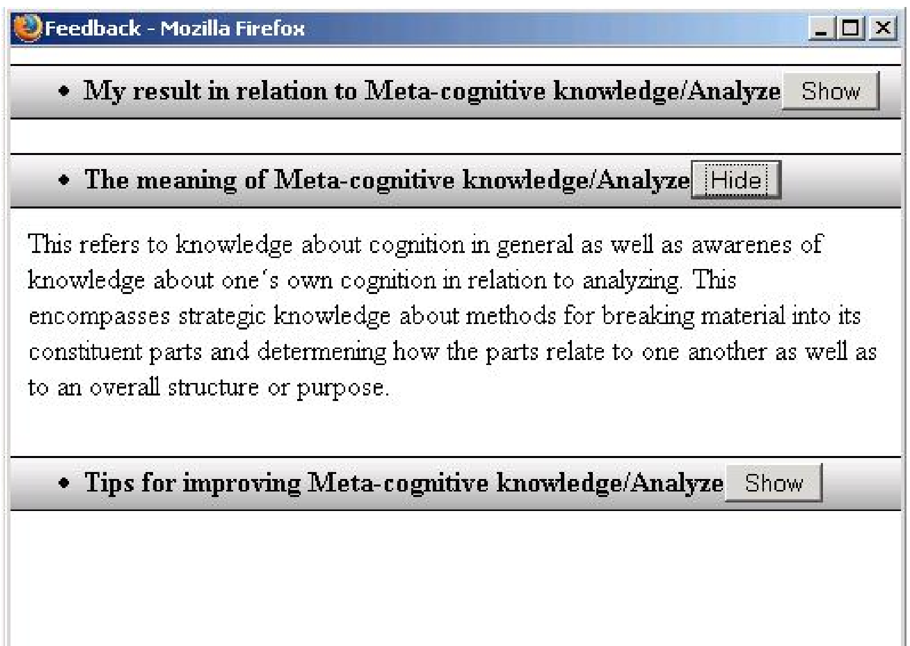


Figure 7. An explanation of analysing knowledge on a meta-cognitive level.

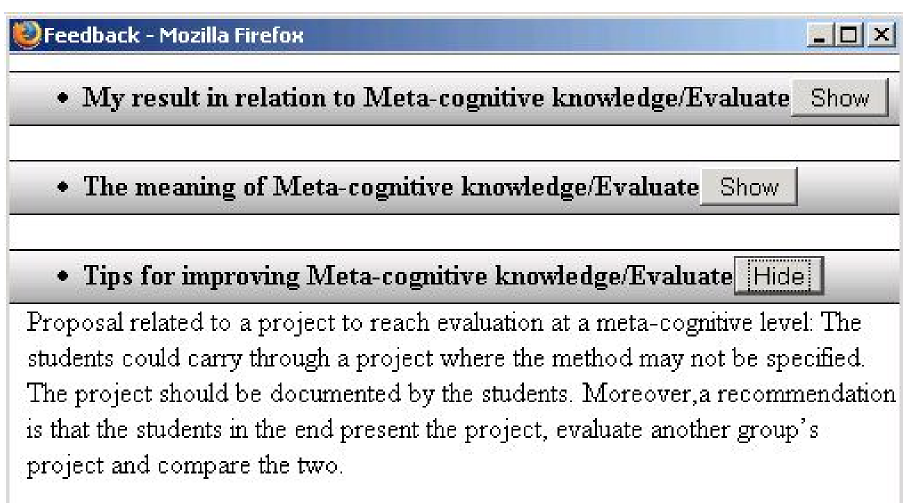


Figure 8. Suggestions for a project related to D5.

Our goal is that Mentor should support the teacher's reflection over the result through the different kinds of feedback and explanations. Furthermore, working with the system can be a continuous process; the system "remembers" what the teacher has answered at earlier sessions and the teacher can update with new information.

4 Mentor's architecture

Mentor is a knowledge system, which can perform problem solving based on knowledge within a restricted domain. In a support system it is important that the system comprises both the knowledge needed for the reasoning and the context to this knowledge. Moreover, this is vital if the user should be able to learn during the session with the system (Edman, 2001).

The notions of conceptual and inferential context are introduced (Edman & Hamfelt, 1999; Edman, 2002). The conceptual context is, e.g., different kinds of explanations of the domain knowledge, figures showing relations between objects and conclusions and conceptualisations of the domain. The inferential context mirrors the problem solving.

In the design we have presented five different kinds of feedback:

(1) Blooms revised taxonomy after the teacher has answered all questions about his/hers teaching strategies (Figure 4).
(2) Explanation why a square in the taxonomy is marked (Figure 5).
(3) Explanation of a concept in the knowledge dimension or the cognitive process dimension (Figure 6).
(4) Explanation of a square in the taxonomy, i.e. a combination of the knowledge and cognitive process dimension (Figure 7).
(5) Proposal how to reach a square in relation to a special question (Figure 8).

The feedback in (1) – (2) are dynamically generated related to what the teacher has answered during the session and (3) – (5) show static explanations. The first two can be seen as the inferential context, related to the current reasoning in Mentor, and the other three are parts of the conceptual context which is always present. Presentation of the conceptual context is in Mentor based on an informal theory, IT, see Figure 9. The domain context representing the problem solving knowledge is called the object theory, OT. This refers to, e.g., how to evaluate the teacher's answers and map it to the taxonomy. Information generated regarding the inferential context is based on both OT and IT. OT is used for the actual reasoning, but IT comprises the knowledge that can be presented regarding the result. A metatheory, MT, performs the reasoning in the system. MT carries out the reasoning based upon the problem solving knowledge in OT, and the user's knowledge and also integrates the user's answers in the system. Moreover, MT generates and presents domain knowledge based on the inferential and conceptual context respectively.

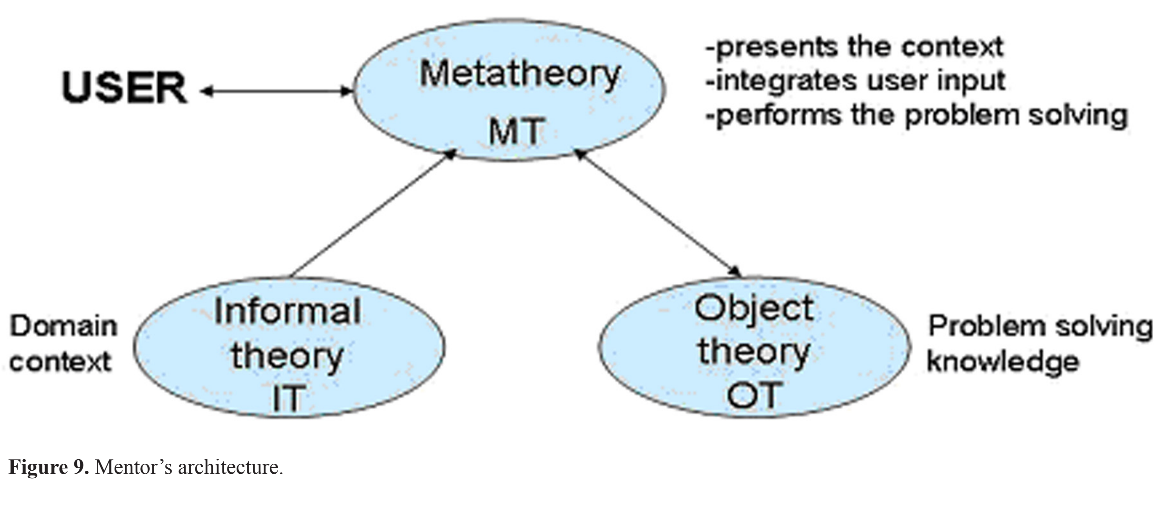


Figure 9. Mentor's architecture.

In OT, general domain knowledge may be represented as facts, heuristic rules for reasoning within the domain, meta-rules, i.e., rules about rules, structured objects, and decision tables (Awad, Ghaziri, 2004). We have chosen to use heuristic rules. Some of these are presented in Figure 10 and 11. A rule consists of a conclusion and premises, where the premises state the prerequisites needed to be able to show the conclusion. The rules 100 – 102 describe some of the relations between the teacher's answers and the taxonomy. Rules 200 – 201 are based on other rules counting the number of matches in every square in the taxonomy. These rules evaluate the teaching according to the distribution in the taxonomy and rule 300 give a conclusion regarding the teaching strategies. The confidence in the conclusion is described in parenthesis. It is often the case that a heuristic rule does not categorically describe that the conclusion is true or false.

The domain knowledge is based on literature in pedagogy, interviews with pedagogues and our own experiences (university teachers since 1979 and 2001 respectively).

```
Rule 100
Taxonomy A1 IF
    Quizzes = "yes"

Rule 101
Taxonomy B2 IF
    Oral presentation = "yes"

Rule 102
Taxonomy C3 IF
    Project = "yes" AND
    Level of description = "thorough" AND
    Documentation = "yes" AND
    Oral presentation = "no" AND
    Evaluating other projects = "no"
```

Figure 10. Heuristic rules relating answers and the taxonomy.

```
Rule 200
Teaching "up to D5" (with probability) IF
    Number in taxonomy D4 > 4 AND
    Number in taxonomy D5 > 3AND
    Number in taxonomy C5 > 5
Rule 201
Teaching "up to D5" (with possibility) IF
    Number in taxonomy D4 = 2 – 4 AND
    Number in taxonomy D5 = 2 – 3 AND
    Number in taxonomy C5 = 3 – 5
:
Rule 300
Teaching strategies "with high diversity" (very
probable) IF
    Teaching "up to D6" (at least with possibility) AND
    Teaching "up to D5" (at least with probability)
```

Figure 11. Heuristic rules evaluating the teaching.

For the moment the feedback in IT is based on text only, but it will be possible to utilise hypermedia later on. Then the feedback can be verbal and also illustrated in form of e.g. films from lectures and laboratory experiments, examples of tasks for exams, and design of projects. Such illustrations can hardly be general but has to be related to a specific subject. On the other hand, it is possible to get ideas from other subjects to one's own.

5 Knowledge management and leadership in educational organisations

The knowledge management life cycle can be seen as a four-step process; capturing, sharing, and applying knowledge, and then creating new knowledge (Liebowitz, 2001). Nonaka and Takeuchi describe knowledge creation and transformation as a knowledge spiral (1995). Creation of organisational knowledge develops through a continuous and dynamic interaction between tacit and explicit knowledge. ICT, e.g. knowledge systems, may support in this interaction.

Educational organisations are, by their nature, knowledge-dense and it is important to take care of the knowledge and share it among the employees to create new knowledge. In the knowledge management process it is vital that the leaders inspire the employees to deal with capturing and processing knowledge. This can be compared with the educational organisation, where the teacher leads the students in their learning activity. Harris and Muijs argue that the teacher's leadership is mainly focused on developing high quality learning and teaching in schools. Several studies, from different countries and school contexts, show the powerful impact of leadership in securing development and change in schools (see e.g. Harris & Chapman, 2002).

There are mainly three categories of leadership; autocratic, democratic and laissez-faire (Lewin et al, 1939). Autocratic leaders are focused on their own ideas and will do what they consider right without accepting other members' suggestions and ideas. They don't consider other team members as equally important and sometimes they will enforce members to obey their decisions by rewarding or by punishing them. In contrast, democratic leaders have a close relationship with other group members and they will encourage all the members to participate in planning and at the same time value their ideas and suggestions when making a decision. Finally, laissez-faire leaders have too much confidence to other group members and do not try to control the group members. They do not put any concrete goals to be achieved, therefore the members are free to decide for themselves what to do. This kind of leadership style will work if the group members are extremely competent in their field.

5 Concluding discussion

Knowledge management refers to people, processes and technology within an organisation (Awad & Ghaziri, 2004). The goal is to create the knowledge that drives the organisation forward and results in a more successful management. Educational institutions, as other organisations, need to be able to manage the corporate knowledge, and technology, e.g. in form of knowledge systems, can be a support in this management.

In educational organisations the main task is to facilitate the student's learning. This can be enhanced by providing support for individuals and, moreover, by facilitating the need for individuals to work together so they can develop an understanding of a collective vision (McNeill et al, 2003). According to Bloom (1956) student-centered methods for teaching, e.g. discussions, are thought to be more effective in developing higher-order intellectual skills, such as creating and problem-solving. We mean that educators with a democratic leadership style can take a student-centered approach and thereby improve student's learning capacity.

Our goal is to supply a knowledge system, Mentor, as a tool for teachers to get insight into their tutoring and thereby explore the opportunities of adopting student-centered teaching strategies. We have chosen the revised Bloom's taxonomy in Mentor of two main reasons: on the first hand to map teachers' answers to the taxonomy and on the other hand to give the teachers different kind of feedback based on the educational objectives in the taxonomy. Through the taxonomy Mentor highlights where in the taxonomy the teachers´ strategies are placed and will give feedback about how the current strategies can be improved.

It is worth to note that in this paper we have only introduced a prototype, with both technical and pedagogical constraints, as the first step toward building the system. Our plan is to further develop it to a complete and working system and test it in a number of schools. Two master students in Computer Science have decided to develop Mentor further in their master thesis during spring semester 2007. For the moment, the user's interaction with Mentor is text based. In the future we will utilise knowledge-based hypermedia. With a knowledge-based hypermedia technique it is possible to reason about the current user's needs and to generate presentations according to this (Edman, 2001) thereby support the users with different learning styles (Edman & Mayiwar, 2003). It is possible to utilise knowledge-based models of the learner (Gobet & Wood, 1999; Wood & Wood, 1999) to be able to tailor the feedback to the current user's need.

To summarize, in order to improve the learning capacity and help students to achieve deep knowledge, the teaching process should be focused on students' involvement in their learning, which is in accordance to the constructivist approach. For this reason, a student-centered learning environment, where the teachers are democratic leaders, is considered as an important prerequisite. Thus, we have in this paper offered a support system for teachers to check their current teaching style and to hopefully move toward a more democratic leadership style in order to assist the students in their efforts in accomplishing a holistic comprehension of the studied subjects.

[3] http://www.ncsl.org.uk/media/1D5/A9/teacher-leadership-summary.pdf

Successful leadership is a key constituent in achieving school improvement (Offsted, 2000, in Harris & Chapman, 2002). Therefore, a task for knowledge management in educational organisations is to influence the teachers so they change their leadership style from, a more or less, autocratic to a democratic style. A knowledge system, such as Mentor, may support such a change. A spin-off is that the teachers' leadership style applied in the classroom may have impact on students' view of democracy. Few schools operate democratically but when teachers take on leadership roles beyond the classroom their schools can become more democratic than dictatorial, and everyone benefits (Usdan et al, 2001). The more democratic school culture, "the more students come to believe in, practice, and sustain our democratic form of governance" (ibid).

As stated earlier, knowledge management comprises capturing, sharing, and applying knowledge, and then creating new knowledge. In Mentor we have captured pedagogical knowledge that can be shared by the teachers, they can apply it in the classroom and, hopefully, through the application create new knowledge, such as how to deal with their own subject in relation to new teaching strategies. The knowledge they create may be captured and stored in Mentor, shared by the other teachers and so on in a spiral. It is obvious that a knowledge system like Mentor can be an integral part in a knowledge management system for educational organisations.

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Enhancing Learning With a Group Support System Facility

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This paper describes the theory behind, the facilities of and some cases carried out in the Laboratory of Decision Support Systems at Lappeenranta University of Technology. The aim is to map the benefits of the GSS and the challenges that group work and collaboration present to it, as well as to bring the laboratory forward as a viable tool for education. The first chapters discuss the general theory and practice in group support systems. Secondly, the attention in this study turns to problem-based learning, its challenges and use of the laboratory as a learning environment, as well as the facilities of the laboratory.
The case section of this paper presents experiences of using the GSS in managerial planning and selection tasks. The case descriptions illustrate the process and practice in the presented cases and give an overview of the results from a learning perspective. The cases in general provide support to the theoretical benefits of using a GSS and the sessions show many of the proposed upsides of using a GSS.
Finally, the learning results are drawn together and summarized. The results could to be considered as cautiously positive, but as often is the case, there are still questions to be answered and topics for further research.

Keywords: Group Support System; GSS; GDSS; Problem based learning

1 Introduction

A group support system (GSS) is a collection of applications aimed at facilitating group work. It allows collaboration either on-site or out of different locations. A typical face-to-face GSS room comprises a variable number of terminals in a network combined with various audiovisual systems. The GSS concept aims to bring systematic procedures and benefits from IT development to support team work in a manageably way. This is done by enhancing the process gains and reducing the process losses occurring in a teamwork environment. In practice this is means appointing a meeting leader, creating a clear structure for the meetings, and with methods made possible by the utilization of IT, such as parallel input, the ability to post messages anonymously, or electronic documentation.

The use of the GSS has been widely studied in many different working situations. Fjermestad and Hiltz (2001) have conducted a wide literature study covering 79 published papers with 54 case and field studies, where they found strong evidence that the GSS improves the efficiency, effectiveness, consensus, usability, and satisfaction compared to that

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of manual group work methods. De Vreede et al. (2001) reached a similar result, additionally finding support for cost efficiency due to the increased efficiency in the meetings. In addition, the GSS has been shown to be a positive environment for more effective learning, thus enabling efficient knowledge creation (Garavelli et al., 2002).

Lappeenranta University of Technology (LUT), especially the Laboratory of Decision Support Systems, has used the available collection of support systems in industrial casework and for educational means. The focus of research is on developing processes and tools for industrial management and relating decisions and problem solving, an aim that is also reflected in the teaching of the Department of Industrial Engineering and Management. The department uses the best practices acquired from research to teach the use of decision support systems (DSS), especially group support methods to graduate students in realistic situations to solve problems and make decisions in complex un- or semi-structured situations, using a problem-based approach to learning.

This paper contains a general introduction to the GSS, its abilities and possibilities as a teaching facility, and a description of some of the cases solved in the laboratory. The aim is to map the benefits of the GSS and the challenges that group work and collaboration present to it, as well as to bring the laboratory forward as a viable tool for education and discuss the possibilities for further development, especially in the learning sense. This paper is a descriptive case study (Yin, 1994). As such, the empirical section presents the phenomena encountered in the course of using the laboratory as seen by the researchers, but does not attempt at strictest empirical scrutiny.

2 Group support systems

Group support systems are a form of groupware designed to support teamwork and decision making by electronic mediation. There has been some confusion in the literature on the terms concerning groupware and the GSS. To clarify the definitions, Figure 1 below illustrates the hierarchy of communications driven decision support systems (DSS). As an observation, groupware is seen as a higher concept than the GSS, but in many sources, groupware is seen as more of a parallel system (Turban et al., 2005; Benbunan-Fich et al. 2002). The problem is that both groupware and the GSS are defined as computerized systems designed for facilitating group work, and in many cases they use similar tools, but in practice the uses differ.

Group support systems are a collection of applications aimed to facilitate group work and communication, similar to groupware (Turban et al., 2005; Jessup and Valacich, 1999). In the general hierarchy of decision support systems, the GSS is placed in the branch of communication-driven DSSs (Power, 2002). The early definition by Jessup and Valacich (1993) states that GSSs are computerized information systems, which are used to support intellectual, collaborative work. Another way of describing a GSS is that it is ”a collective of computer-assisted technologies used to aid group efforts directed at identifying and addressing problems, opportunities and issues” (Huber et al., 1993)

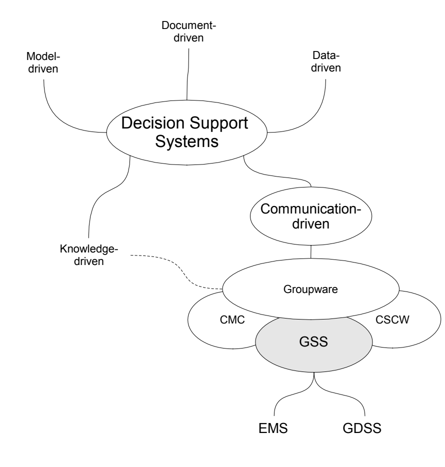

Figure 1. A taxonomy of decision support systems (adapted from Power, 2002)

Turban et al. (2005) bring forward the layered nature of the system. A complete GSS consist of layers of hardware and software, as well people and procedures (Table 1). A GSS facility can be located in one room (a decision room) in order to create a decision conference, which is attended by an appropriate group of individuals, and the purpose of which is to consider various options and find a solution to a problem. However, a GSS can be extended for use in different places and at different times (Sauter, 1997). The GSS time/place –framework was originally put forward by DeSanctis and Gallupe (1987), and it describes four distinct settings; the same time and place or *synchronous face-to-face (f-to-f)* setting, the same time but different place *decentralized setting*, *asynchronous f-to-f,* and *decentralized sessions*, where the system stores input of the earlier contributors, for example in a situation where the participants are on different continents. However intriguing these 'advanced' settings might be, this study focuses on the basic synchronous *f-to-f*–setting.

A typical GSS for a face-to-face meeting is a decision room where the participants use computers to interact at the same time and in the same place. The decision room environment has been used in the cases of this study, and in this study the term GSS is used to describe an interactive computerized system that can support the group work process and that also has phases of verbal, non-computer-supported communication in an f-to-f environment. A GSS meeting is seen as a process that has phases of computer-supported and verbal communication, as a result of which the group does not rely entirely on computers during the meeting.

Table 1. The components of a GSS (Turban and Aronson, 2002)

Components	Includes
Hardware	- PCs or keypads - networks; LAN, web - decision room, distributed GSS - additional technology; data projector, videoconferencing cameras, A/V equipment
Software	- an easy-to-use and flexible interface - modules to support the individual, the group, the process and specific tasks - numerical or graphical summarization of issues and votes - anonymous data recording - text and data transmission among the group members - e.g. GroupSystems.com, Facilitate.com, Meetingworks…
People	- group members, chairman, technical facilitator - the system itself does not contribute any information to the decision making - selection of the right group members is a critical success factor
Procedures	- ensuring ease of operation and effective use of the technology - a set of rules allowing the definition and control of a group meeting plan - the importance of agenda and pre-planning of the meeting; the meeting process forms the foundation for the matter to be dealt with - different procedures for different meeting environments (f-to-f, asynchronous…)

3 Challenges in group learning and the features of the GSS

Group work has several advantages over individuals, as groups are particularly good at combining talents and providing innovative solutions to possibly unfamiliar problems; the fact that a group possesses a spectrum of skills and knowledge over an individual is a distinct advantage in favour of the group. Despite the generally accepted positive sides of group work, investigations into the effectiveness of group activity have produced mixed results. Campbell (1968) found that the "best members" performed better than the group as a whole. Huang et al. (2002) have studied the subject more recently, arriving at a proposition that group productivity is a factor of team cohesion, motivation and habituation to the used work methods. On the other hand, Laughlin and Barth (1981) observed that the group's performance was better than an individual's performance.

Group work is also common in problem-based learning (PBL). Generally, PBL techniques aim at "deepening" the learning experience, and referring to the common conception of learning strategies, it could be suggested that PBL motivates the group to work on the problem at hand and use their expertise with others in new ways (Poikela and Poikela, 1997). Case-based teaching is a common form of PBL in the field of industrial engineering and management and e.g. medical education. The basic setting in case-based teaching is to present a problem, or a problem scenario, to the students to which they seek to apply their knowledge of the subject and the methods they possess (Savery and Duffy, 1995). Many courses at LUT, as well as at other universities in the field, utilize case files that describe a situation of or a problem in a real or fictional company, and the students are assigned to solve the given problem or analyze the situation, using their prior knowledge and the tools provided during the course. PBL stresses the students' role as independent actors in learning and the role of the teacher or tutor as a facilitator, rather than the source of knowledge (Alanko-Turunen and Öystilä, 2004).

There is some anecdotal evidence also from inside LUT to support the use of realistic cases. A course primarily taught in the laboratory adopted one large case file with exercises for the students to work on, which build on the previous work on the case, instead of separate more mechanical exercises. Regarding the exercise plan, students have expressed that working on the same company with realistic and challenging problems has been more rewarding than most other courses using case-based teaching or other methods. The situation does not necessarily differ much in the industrial scenarios, as the facilitator is present in the meetings to use the GSS software and other tools, as well as guide the group process, whereas the participants will have to use their expertise to solve the actual problems with the tools and frameworks brought forward by the facilitator. In fact, reflecting the typical industrial case with the PBL-process presented by Poikela and Poikela (1997), and Alanko-Turunen and Öystilä (2004), it might be suggested that, as the setting, and balance of power if you will, is different with industrial participants, these sessions are PBL par excellence.

From time to time, there have been references to using a GSS for learning and education, e.g. Alavi (1994), Walsh et al. (1996), Kwok and Khalifa (1998b), Tyran and Shepherd (1998) and Kwok et al. (2002). As often is the case, Tyran and Shepherd (1998) found mixed results in their review of learning with a GSS in respect to performance and other factors. Due to different settings, it is indeed difficult to judge which results are more descriptive. Similar inconsistencies have been observed in the general GSS field (Fjermestad and Hiltz, 1999), which in turn has been explained by a 'black-box' approach to research (Limayem, et al. 2005) and the participants habituation to electronic communication (Huang et al. 2002).

As for PBL and a GSS, the ideals of PBL, especially as group activity, seem to be democratic processing, constant reflection and review, fluid teamwork and collaboration, and learning from others in the group (Öystilä, 2002). Similarly Kwok and Khalifa (1998b) list the qualifications for meaningful learning to be active participation, cooperation and problem-based learning, which then should lead to meaningful learning. Reflecting this with the features and benefits of a GSS discussed above seems to suggest that a GSS would be a promising medium for education. Table 2 presents the features of a GSS with the challenges in group learning, to illustrate the benefits achievable by using a GSS. According to several studies, a GSS is superior in a conventional meeting in the following possibilities it offers for supporting a group in promoting cooperation and effectiveness: a GSS disperses information between the participants and allows constant reflection, as the input of the group is updated to everyone's screen in real time; the system by and large alleviates problems in group dynamics and allows more democratic sessions and moreover, depending on the group and its habituation in electronic communication, a GSS may also enhance group cohesion and knowledge creation (Garavelli et al., 2002; Huang et al. 2002).

Table 2. Benefits of a GSS and challenges of group learning (Turban et al., 2005; Alanko-Turunen and Öystilä, 2004; Öystilä, 2002; Kwok and Khalifa 1998a, 1998b; Nunamaker et al. 1997; Gessner et al., 1994; Jessup and Valacich, 1993)

<table>
<tr><th>GSS features</th><th>Description and advantages</th><th>Benefits</th><th>Challenges</th></tr>
<tr><td>Process structuring</td><td>Keeps the group on track and helps them avoid diversions:
- clear structure of the meeting; improved topic focus; systematical handling of meeting items; discussion seen to be concluded; electronic display makes the commitments public</td><td>- Greater commitment
- Improves goal-orientation
- Improved quality of results
- Immediate actions</td><td>- Maintaining goal orientation
- Lack of motivation
- Motivation and commitment</td></tr>
<tr><td>Anonymity</td><td>Members' ideas, comments and votes not identified by others:
- more open communication; free anonymous input and votes when appropriate; less individual inhibitions; focus on the content rather than the contributor; enhanced group ownership of ideas</td><td rowspan="2">- More/better ideas
- Greater commitment</td><td rowspan="2">- Groupthink
- Domination by the few
- Fear of speaking
- Balance of student-teacher communication
- Inefficient work in large groups
- Favouritism in micro groups</td></tr>
<tr><td>Group size</td><td>Allows larger group sizes:
- facilitation of large groups easier with tools; enhances the sharing of knowledge</td></tr>
<tr><td>Parallelism</td><td>Enables many people to communicate at the same time:
- more input in less time; reduces dominance by the few; opportunity for equal and more active participation; participation and contribution at one's own level of ability and interest; electronic display distributes data immediately</td><td>- More efficient sessions
- Improved quality of results
- Stimulates individuals to participate</td><td rowspan="4">- Fear of speaking
- Communication barriers
- Learning from others
- Encouraging multidisciplinary thinking
- Reflection of input
- Reflection of results
- Fluid teamwork</td></tr>
<tr><td>Group memory</td><td>Automatically records ideas, comments and votes:
- instantly available meeting records; records of past meetings available; complete and immediate meeting minutes</td><td rowspan="2">- Better documentation
- Immediate actions
- Access to new and old information for efficient knowledge creation</td></tr>
<tr><td>Access to external information</td><td>Can easily incorporate external electronic data and files:
- integration with other data systems; effective sharing of needed information</td></tr>
<tr><td>Data analysis</td><td>Automated analysis of electronic voting:
- voting results focus the discussion; software calculates e.g. the average and standard deviation of the voting results</td><td>- Better understanding of input
- Better documentation</td></tr>
</table>

4 The GDSS laboratory at Lappeenranta University of Technology

Lappeenranta University of Technology has a GDSS laboratory, which is used for teaching and research in the field of group decision support processes and systems. The purpose of the research is to develop the planning and evaluation processes for demanding management tasks in industrial enterprises. Some of the more notable cases have been in the fields of strategic planning, technology management and product innovation management. The laboratory has been utilized for defining the critical success factors of companies, selecting strategies and executing SWOT analyses, generating concepts for new products, defining new concepts, selecting projects, carrying out customer need assessment, promoting the selection process of R&D measures, and specifying the requirements for systems that are to be purchased.

The main group support software of the laboratory is the GroupSystems developed by the University of Arizona and Ventana Corporation. The GroupSystems comprises half a dozen different tightly integrated applications or tools, which support different phases of group processes, such as brainstorming, list building, information gathering, voting, organizing, prioritizing, and consensus building. The laboratory has been designed to support up to ten-person electronic meetings, and there is a possibility for remote use within the University. The laboratory is a PC-equipped Local Area Network -based meeting room designed especially for decision-making, and various commonly used decision support software have been installed. The laboratory houses also several other applications beside the actual GSS. The extensive collection of decision support tools gives a solid foundation to the decision room. The software bundle includes tools for e.g. system dynamics, analytic hierarchy process, causal mapping and decision trees. By combining these tools, it is possible to increase the quality of the made decisions and the group work.

Figure 2 below illustrates the layout of the laboratory. The main feature is the horseshoe-shaped conference table, which faces a large common screen connected to the facilitator's workstation. The room is designed to look like an ordinary meeting room, but the table houses ten workstations for the participants hidden inside the table, which allows quick and flexible switching between computer-supported and ordinary meeting activities.

In addition, the displays are under the glass surface of the table so that the displays do not dominate the appearance of the room and every participant has a clear eye contact with the others. The laboratory also contains standard software and general meeting room equipment, such as an overhead projector. There are also two SmartBoards, that is, two touch sensitive medium-sized projection screens with independent desktops. The boards allow drawing and note taking directly to the screen with special felt tip pens, as well as editing existing content or drawing on other documents, and the input can be saved and sent to the participants.

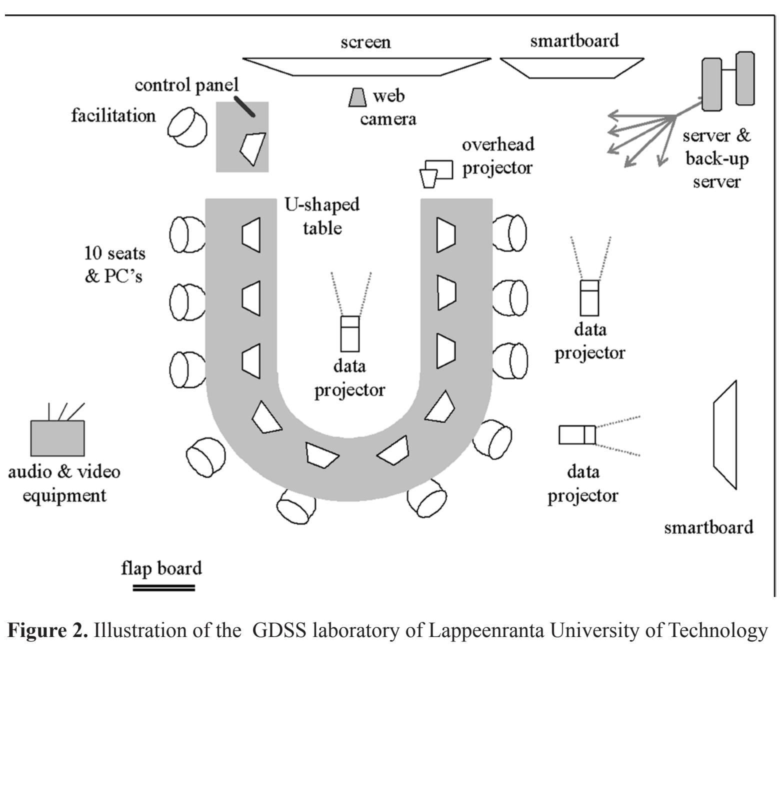

Figure 2. Illustration of the GDSS laboratory of Lappeenranta University of Technology

Then becomes the apparent question; what does this laboratory environment allow to do in industrial and teaching cases? Firstly, the extensive collection of tools allows relative freedom of accepting cases to be worked with, and similar freedom to session planning, as the facility is not the first limiting constraint. Secondly, the variety of available methods gives the possibility to develop multi-method frameworks to leverage the strengths of each single method to alleviate the problems in others, it allows benchmarking methods and tools against each other for added validity in complex and important decisions. Thirdly, it allows giving a comprehensive view of the possibilities of decision support to the students, and thus provides good foundations on the subject. As for the question of whether the laboratory adds value to teaching or other activities, the reviewed literature and the studies undertaken at LUT have indicated a high level of satisfaction to the sessions, and good performance in respect of reaching the set goals. On the basis of this, it could be reasonable to suggest that the support systems do indeed benefit the group process and by that also enable more efficient learning (Kortelainen et al. 2006; Piirainen, et al. 2006; Elfvengren et al. 2003, 2004).

5 Case examples of the use of the GDSS laboratory

This chapter presents some cases from the laboratory. As already above, the laboratory has served in different planning, analysis and decision cases in education and also projects within a variety of industries. The selected cases are instances which have been evaluated and reported in other contexts, so they should offer a presentable section of the work history of the laboratory. Each case uses a tool or tools not generally used in industry, which should broaden the view to the applicability of the laboratory environment in a variety of situations. The overviews offer a short introduction to the theoretical and practical background in the case, a description of the work process and progression of the case, and a summary of observations and findings concerning the learning aspect in the cases.

Meeting satisfaction is an important measure in general information systems research and a measure of GSS technology effectiveness. This is because unless the use of GSS technology produces an increase in meeting satisfaction, it is unlikely that the users will seek to adopt the technology, regardless of any productivity gains that might be realized (Reinig, 2002). However, the problems of measuring actual learning by course grading are well known. The survey measures the students' outlook on the course arrangement, and as such cannot be used to validate the learning results. On the other hand, the survey gives an overview of the students' satisfaction to the system, which can be seen as an enabler to learning, if not an actual measure for it. Meaningful evaluation of the net effect of GDSS for learning in the presented cases is a task not possible to complete on an ex post basis, but nevertheless it is fruitful to provide some evaluation to the cases.

The cases presented in this paper were evaluated partly by collecting course feedback from the students. This survey evaluates student satisfaction about the whole course, which includes lectures, exercises in the GDSS laboratory and a term paper. Table 3 presents the general feedback from the students. The last column shows average student answers on the scale of 1 to 5, where 1 means "not at all/very poor" and 5 means "very good/high". In addition, there were some open-ended questions about how the students felt about the GSS exercises.

Table 3. Course feedback survey questions and average answers

Question	**Avg.** n=19, (scale 1 to 5)
I put a lot of effort to this course / I participated actively in this course.	3.8
Participation and studying in this course was interesting.	3.6
The working methods fitted well for the course and the methods supported my learning.	3.9
I can exploit and apply the skills and knowledge which I obtained from this course.	3.8
Overall grade for the course.	3.6

Most of the students who responded the open-ended question, “What did you think about the GSS exercises?” listed very positive comments, such as ”the GSS exercises were the best part of the course”; ”the GSS exercise concept was good”; ” the exercises were pleasant and I learned from them better than from the lectures and seminars”; ”the exercises deepened my understanding of the theories in the lectures”. These answers give some evidence that the GSS concepts used in the exercises were perceived as interesting and useful by the students. It also seems that these GSS cases enhanced the learning by showing the students practical means and methods to solve complex problem and planning situations. The overall student satisfaction in the whole course seems also better than average, which could indicate that the GSS exercises were found to be a functional part of the course and suitable for learning purposes.

5.1 Idea generation in the GDSS laboratory

In idea creation cases, the group size is generally 6-10. The session begins with an introduction to the day’s agenda. After the introduction, idea creation begins with electronic brainstorming. The basic rules of brainstorming are applied to the idea generation session; freewheeling is welcome, quantity is wanted, criticism is forbidden, and combination and improvement are sought (Osborn, 1953). Brainstorming is followed by categorizing the ideas and priorization by voting. A typical session lasts approximately 90 minutes, during which time many common phenomena can be witnessed, such as M-curve and group memory. M-curve is an illustration of the volume of ideas per minute generated over a given amount of time; the illustration often looks like the two arches of the letter M (Haman, 1996). Breakthrough ideas are supposed to materialize more likely in the second arch of the M-curve, so it is justified to stretch the idea generation time. There are also some generally noticed problems in traditional brainstorming, such as social loafing, evaluation apprehension and waiting for a chance to speak, which can be seen relatively easily in normal brainstorming.

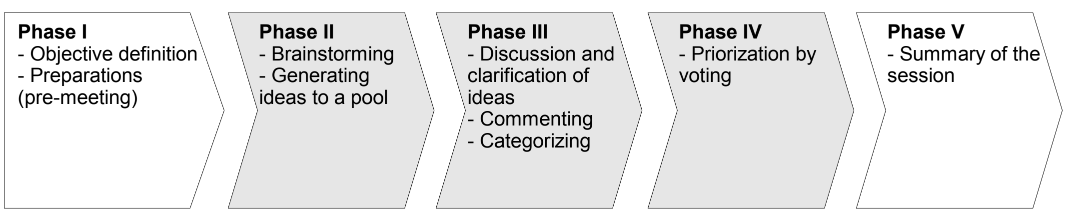

Figure 3. Process of idea generation

The findings of the student cases are in line with similar cases done with industry settings (Elfvengren et al., 2005). The students showed increased participation and found the system easy to use. As an educational tool, the GSS offers opportunities for teachers. Students can compare the traditional brainstorming method and electronic brainstorming in the laboratory sessions. This way the use of the GSS enables the presentation of the mentioned group dynamical phenomena found in brainstorming and the benefits of supporting the process in a very concrete way to the students. Then as the students are able to reflect these experiences in a control session, the usefulness of the GSS in reducing these problems can be easily demonstrated, as described. The phenomena include group memory, which enables ‘piggy backing’ on others’ contribution as the processing is parallel and the input is commonly viewable, and displaying the accumulation of ideas as a function of session time in turn demonstrates the M-curve effect. Considering the learning aspect, this case allows the students to reflect their work practices and teamwork skills, as well as functions as an introduction to the benefits of the GSS.

5.2 Scenario planning in the GDSS-laboratory

In examining the scenario process, the possibility of using the GSS to make the process more efficient and effective became apparent. The basic concept in developing scenarios is bringing a group of experts together and synthesizing their understanding of the future to a set of plausible scenarios. For this, the scenario process was examined further and the result is illustrated in the following figure.

In the scenario planning case, the team size was 10-20 people, and the students either worked as a pair on a single computer or by themselves, depending on how many participants were present. The session followed the process presented in Figure 4 and it took 100-150 minutes to complete. In practice, the sessions went from a short presentation to identifying the drivers, which were discussed briefly and printed to every participant. After that, the group was asked to identify concrete events which would be triggered by the drivers in the given time span. After the events were once again discussed, they were voted for probability of occurring and impact on the target organization. Out of these events, three sets were grouped to form a scenario each, which form the base of a scenario set. After the session, the events and the drivers were formed to concept maps, which were presented to a select audience and corrected according to comments on the spot using a smart board.

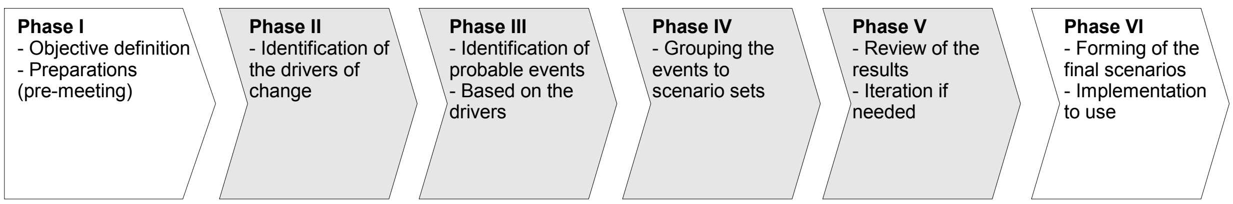

Figure 4. A GSS-supported scenario process (adapted from Bergman, 2005; van der Heijden et al. 2002; Schoemaker, 1991)

Like in the idea creation case, in the scenario planning the GSS showed positive effects on group member participation. In the scenario process, the group tries to build common understanding of the situation by analyzing the problem together. In the case of scenarios, the problem is the future state of e.g. a particular industry or technology. The students felt that the procedure gave the session a systematic backbone. However, there were also perceived inconsistencies in the process, which lowered the trust in the results. In a more motivated business case, the results show increase in confidence on the results. As a learning tool, GSS offers a method for interactive learning. The combination of GSS and scenarios offers lucrative options especially when a group needs to build understanding of the development of e.g. an industry by identifying the forces and trends that influence the development.

5.3 Business intelligence exercise

Generally, cluster analysis, or clustering, comprises a wide array of mathematical methods and algorithms for grouping similar items in a sample to create classifications and hierarchies. The clustering methods are used widely in empirical and social sciences to classify and group observations to comprehensible and representative groups. Without going into too much detail, clustering may answer questions like "how can we group and classify this dataset?" "to which class does this particular observation belong to?" (Witten and Frank, 2005; Everitt et al. 2001)

In a practical industrial management framework, clustering methods can be used for example in classifying a customer database to internally homogenous user groups for e.g. marketing purposes. Two cases undertaken at LUT are examples of experimental use of clustering in the scenario process (see the previous subchapter) to group the identified event to scenario sets, and educational use of clustering customer information for business intelligence exercises.

In the business intelligence case, the group consisted of 10-20 people who were divided into pairs that worked separately. The basis for the case was a demonstration of the Weka machine learning software to the whole group in the beginning of the session, after which each pair conducted their own work with a generated customer database dataset to form customer segments to support marketing decisions. The casework was done through the trial-error procedure and the tutor was present to answer questions and help the students in their assignment. The session lasted about 90 minutes.

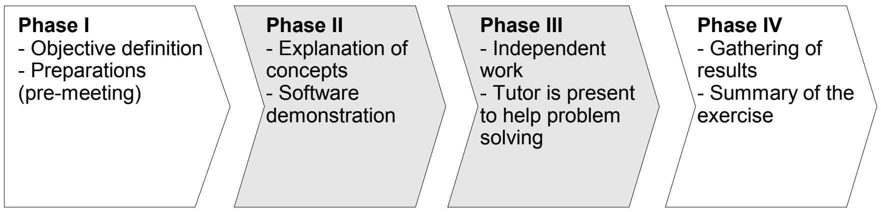

Figure 5. Proceeding of business intelligence exercise

The overall results were good judged as individual achievements toward the session goals. All the pairs were able to complete the assignment and got valid conclusions. However, findings concerning the relative advantage of the GSS facility and learning showed that the situation differed little, or not at all, from a teaching situation in a traditional computer laboratory. Thus these findings suggest that the GSS as a pure technology or the laboratory as an environment has little to offer for learning purposes by itself. These findings offer some support to the findings presented in earlier cases, as the results imply that the procedures and routines are increasingly important over technology if efficient learning is to be achieved in the GSS environment.

5.4 Supporting complex selection decisions

One of the main purposes of the GDSS laboratory is to use it in complex selection decisions that require group work and consensus. The authors have found out that an effective tool for selection tasks is to use the GSS for generating selection criteria and to evaluate the alternatives with the Analytic Hierarchy Process (AHP). The AHP put forward by Saaty (1980) is a technique for supporting selection decisions in a complex environment. The AHP is a multi-objective, multi-criteria decision-making approach that employs a method of multiple paired comparisons to rank alternative solutions to a problem formulated in hierarchical terms (Ramanujam and Saaty, 1981). The AHP is based on three principles: decomposition, comparative judgments, and the synthesis of priorities. The AHP structures a complex problem into a hierarchy (see figure 4). The criteria and the relevant factors are decomposed hierarchically, corresponding to the decision makers' understanding of the situation (Poh et al., 2001; Korpela et al., 2001).

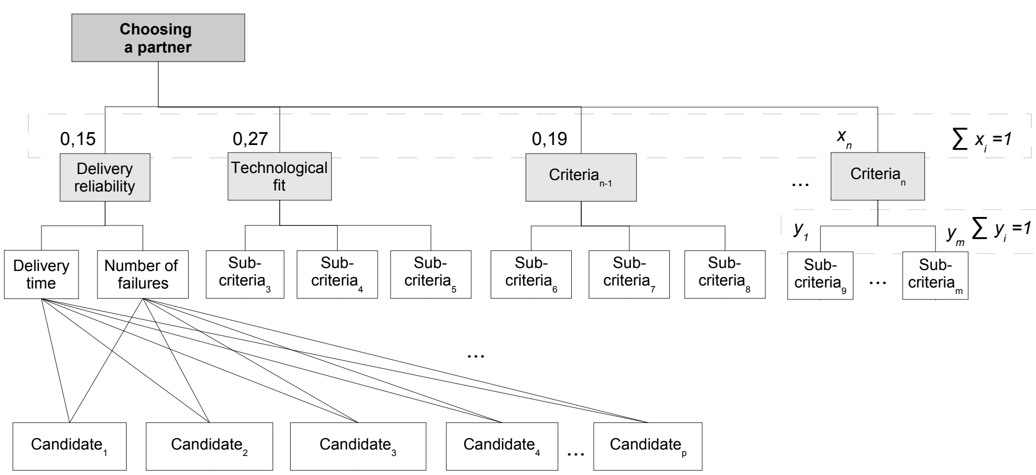

Figure 6. Illustration of the structure of an AHP hierarchy

According to Dyer and Forman (1992), the AHP is well suited to group decision-making, offering numerous benefits as a synthesizing mechanism in group decisions. Group decisions involving participants with common interests are typical of many organizational decisions. With the AHP hierarchy model, the discussion centres on objectives rather than on alternatives. After structuring the AHP hierarchy, the group would provide the judgments using a hierarchy. The debate, which usually occurs in a group priority setting, can be reduced by a questionnaire. If consensus is difficult to achieve, the approach is to have each group member make individual judgments and then combine the results. One way is to use voting and to take an average of the judgments to the model (Sierilä and Tuominen, 1991). In this case, the GSS was used to synthesize the weighting for the AHP hierarchy, as the abilities of the GSS seemed advantageous for the task. On the practical level, Expert Choice software has formed the pivot point for operationalising the use of AHP-techniques at LUT. The weights of the criteria derived from the voting averages of the GSS session are entered directly with the data option in Expert Choice. This approach allows more fluid use of the model for the decision maker, while effectively utilizing the group's collective knowledge, instead of one expert opinion.

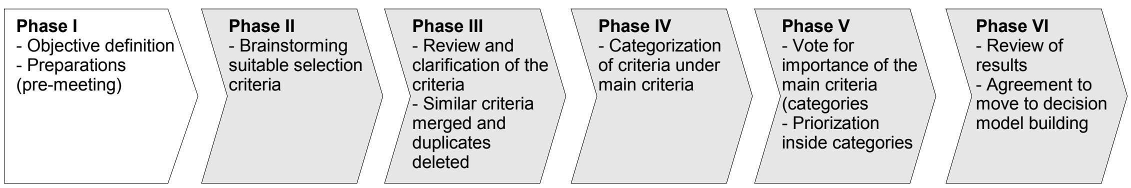

Figure 7. Selection criteria development process

The findings in the student cases suggest that the GSS helps the student group to generate a needed set of selection criteria for the given problem. Each member can propose criteria freely and the group can discuss the proposed criteria openly and evaluate the importance of each criterion. It seems that the collaborative way to generate the AHP hierarchy tree helps the group to understand the complex decision problem better than without any formal group work method. In addition, the AHP hierarchy helps students to evaluate the decision alternatives in-depth, compared to unstructured decisions. The sensitivity analysis feature of Expert Choice offers a graphic tool for the analysis of the decision. The exercise as a whole helps to understand how the used selection criteria and the weights of the criteria affect the outcome of the AHP-model, and also allows the participates to examine their decision making practices and rationality compared to the relative strictness of the AHP-method. With respect to the GSS itself, the results are in line with the cases presented above.

6 Conclusion and discussions

This paper has focused on the use of a group support system and decision room facilities in general, and has given an overview of some of the more notable cases from the laboratory of decision support systems at LUT. Right from the start the objective was not so much to test the facility, than to give a description of the possibilities and experiences for others to consider. The theoretical background suggests that the use of a GSS in learning activities could have significant value in education. If the direction of teaching will evolve from lecturing to a more problem-based and collaborative direction, educators face the problem of how to engage relatively large groups of students in the learning activity, while encouraging everyone to participate and to focus on the subject in hand.

According to the theory proposition, a GSS might offer a good toolset for that purpose, but again the flipside of the coin is that the advantages of a GSS do not come for free and harvesting them requires adaptation from both the students and the educators. As the theory points out, the effective use of a GSS in any situation needs attention to the group process and session planning, as well as some adaptation in the part of the users, as the communication mode will be somewhat different from the traditional spoken and written communication.

In support of the presented theory, the case examples in the study describe the present state of practice in LUT and some results obtained during these exercises. As of now, there has not been systematical testing of learning results or the possible effect of the GSS on them, but some insight has been gained. The overall satisfaction with the laboratory expressed by the participants has been generally good and as far as anecdotal evidence goes, the results are encouraging.

The case examples have been deliberately kept concise, but a more analytic approach to the cases can be found in the writers' previous publications. Table 4 below draws together the most important findings from the case examples for additional illustration.

Qualitative research is normally based on a limited amount of research data, for example on one or a few studied case situations. The reason for this is usually limited time and resources, because understanding one case situation profoundly is laborious and time consuming. The great challenge of this kind of research is to get results, which can also be reliably generalised, to other situations in a similar environment. However, in this study there was no intention to generalize the research results. In the presented cases, it is neither possible nor necessary to prove that the research findings presented in the study are general and suitable to any possible settings. There seem to be some benefits, but the question of which population this can be generalized to and with which limitations, is not effectively answered. These limitations are based on the fact that the actual learning or performance ex ante and ex post GSS sessions has not been measured, or compared to traditional f-to-f workshops or other comparable situations. The findings and conclusions have to be treated as plausible, not generalised normative statements. As of now, the reported results are strictly speaking not generalisable in the sense that they could be extrapolated to other contexts, but rather in the sense that they indicate that there may be benefits to gain in certain populations and session setups.

As a descriptive case study, the contribution of this study lies in the reporting on real world phenomena to open up new research questions for further research. What this study has done, is to present an attractive, and one could perhaps say a novel, approach to exercise problem-based learning more effectively, and by doing this it has posed new challenges for education and educational research. As promising a tool a GSS might be, the advantages are not to be taken for granted. On practical level this would mean further research into the event of using a GSS and studying what makes the event itself successful. The concept of using a GSS seems already to be feasible but as the previous reports indicate, not automatically. These findings should turn the attention of research to not so much proving that a GSS offers a means for learning, but perhaps rather to the process and situational factors as determinants for success to understand how a GSS enhances learning and how these benefits be can harvested. The challenges that arise from these considerations can be seen to be twofold; on one hand there is the challenge of planning the process and everyday teaching activities in education for better utilization of the GSS and groupware technologies, including the benefits asynchronous and decentralised participation might offer, and on the other hand finding and verifying what might be called the critical success factors for utilizing a GSS in education to achieve its full potential.

Table 4. Summary of the case findings

Case	Selection decisions	Learning aspects
Idea generation	- Increased participation - Lively interaction in the group - Traces of group memory	- Students noticed that with a GSS it is possible to generate a lot of ideas in a short time - The facilitation of the group is easier than in open group discussion - It is easier to generate wild ideas when you are an anonymous group member
Scenario planning	- The end product between different groups varied strongly - Students were able to solve an initially hard problem as a group - Some students criticized the quality of some input - The process seemed logical and systematic for students	- GSS helps systemization of the process - Helps in structuring the problem and widens the participants' perspective on the subject - Helps in recognizing the most important factors and promotes open-mindedness - Consensus building and increased understanding on the subject
Business intelligence exercise	- The end products were similar but not identical - Students were able to reach session goals - Pairs needed to be guided separately to some extent	- The net effect of the GSS in learning comes from the process and practice in which the system is used - The laboratory and GSS as such offer little advantage over the normal educational setting
Selection decisions	- Aggregation of group knowledge - Consensus building - Increased acceptance for the results	- Dividing a problem into sub problems help the group to understand the situation better - Division of selection problem promotes objectivity and rationally in decisions - The sensitivity analysis helps to analyse the results and to catch the errors in the model

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Underpinnings of Naturegate® R&D and Business Program for Teaching and Learning about, in and for Natural Diversity

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NatureGate® is R&D and business program at University of Helsinki, connected to CICERO. The aim of this paper is present underpinnings and the probable phase of the NatureGate® R&D and business project in June 2007. Free public NatureGate® service will be presented in practice in the NBE seminar in June 2007. NatureGate® service is a practical example of Network Based Education (NBE). In this paper theoretical and methodological underpinnings of NatureGate® R&D and business program are discussed. It will be shown that at the end NatureGate® will become a service for natural diversity. But first NatureGate® service will start from biodiversity, in particular flowering plant diversity in Nordic countries and Scandinavia. Visions of the NatureGate® R&D and business program will be discussed. In the seminar session examples of how free CmapTools software and server can be used with NatureGate® will be presented, and how this creates data for research on biodiversity learning, thinking and education.

Keywords: free service in the WWW, natural diversity learning, biodiversity learning, mobile plant species identification

1 Introduction

NatureGate® is a social and technological innovation. It is an example of a CICERO initiative. NatureGate® will promote lifelong learning for biodiversity, nature, good environment, sustainable development and good life. NatureGate® is described in more detail in the following documents: Åhlberg, Lehmuskallio and Lehmuskallio (2006a – 2006c); Young, Åhlberg, Niemelä, Parr, Pauleit & Watt (Eds.) (2006). In the long term, NatureGate® will be financially self-supporting in the same way as Google®. Google has shown amazing development from 2000 to 2006 (Battelle 2005, Vise & Malseed 2005). From a humble beginning Google has become one of the biggest and most valuable companies in the world. Google and its rivals have transformed both business and the whole culture by the web search activities they created. The idea of NatureGate® is to become kind of a "NatureGoogle", a free service which creates plenty of added values and business opportunities for everybody, from individuals to societies and organizations, and for the whole humankind. There is emerging understanding of the importance of integrating interdisciplinary research and networked society, lifelong learning, education and importance of healthy sustainable business in creating wealth for sustainable development, good environment and good life (e.g. Åhlberg 1998, Cairncross 2002 and 2006). United nations (UN) has declared years 2005 – 2014 as Decade of Education for Sustainable Development (DESD). Its core concept is integrating ecologically/environmentally, economically and socially sustainable development in all sectors and aspects of humankind. NatureGate® is an innovation to promote UN DESD. United Nations University (UNU), and its Institute of Advanced Studies (IAS), is promoting a new concept on Regional Centers of Expertise (RCE),

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and global learning space they are creating together. UNESCO Chair in Reorienting Teacher Education, Prof. Charles Hopkins (York University, Canada), agreed that NatureGate® servers could be an important part of emerging network of UNU IAS RCEs.

Content of the NatureGate® is and will be based on continual research and development. NatureGate® will promote interdisciplinary research in several ways, e.g.:

(1) creating a comprehensive species centered collection/library of excellent photographs, videos, maps and texts of organisms and their habitats. The photos and videos, and the attached texts, will be aesthetically appealing, and scientifically accurate;
(2) through digital photographs, uploaded by users, including geographic positioning, notes and discussions of users; and through cumulative collaborative knowledge-building by biologists and other scientists, including learning researchers, psychologists and educational researchers.
(3) usability research of all aspects of use of NatureGate®, including use of patented, easy-to-use and fast plant species identification software.

In European Union (2006 and 2007) there are several agreements on importance of lifelong learning: "The aim is to provide people of all ages with equal and open access to high-quality learning opportunities, and to a variety of learning experiences, throughout Europe." This target has underpinnings of emerging knowledge economy, global competitiveness and sustainable development.

In this project an integrating theory of learning is used. Scott and Gough (2003 – 2005) have written about learning and sustainable development in connection to Education for Sustainable Development. The following modern viewpoints are lacking:

- From individual point of view there are three main metaphors of learning: Response Strengthening, Information Acquisition, and Knowledge Construction. (Mayer, 1996 - 2005).
- From social viewpoint of learning there are again three different metaphors of learning: Knowledge Acquisition, Participation and Knowledge Creation, which includes collaborative knowledge building (Hakkarainen, Palonen, Paavola & Lehtinen (2004, 13). Actually the first metaphor concerns individual learners, but it is viewed from viewpoint of communities of learners, and networked expertise. According to Bereiter (2002 and 2003) knowledge building is always collaborative. However, we may argue that Darwin during his voyage around the world, constructed knowledge practically on his own, not collaboratively (Kerrigan, 2005). Through his correspondence and after his first published article, he started to build knowledge collaboratively with other researches (Elredge, 2005).

Learning is a concept used to explain changes in thinking, acting, feeling etc. of both individuals and social entities up to humankind. Learning covers continual integration of complex and multifaceted processes. There are many reasons for syntheses, synergy and integration of learning theories (e.g. Bransford, & al. 2006a and Bransford, & al. 2006b). In this sense learning as a phenomenon is very similar to sustainable development. Learning has many components, with individual and social aspects. Human learning has at the same time all those aspects which Mayer (1996 - 2005) and Hakkarainen, Palonen, Paavola & Lehtinen (2004) have described. In practice teachers and researchers are dealing with whole learning persons, who are thinking, feeling, acting, perceiving and learning continually from childhood to old age (Harré 2002, Jarvis 2006, 194 - 200). Also situational and contextual aspects of learning ought to be integrated when a new and better theory of learning is created (Lave & Wenger 1991; Jensen 2005). Internet opens for the first time a possibility of (almost) all humankind to learn together for alleviating and solving problems of humankind. One of the big problems of humankind is biodiversity loss and loss of free ecosystem services (food, clean water, renewable raw materials and energy etc.). NatureGate® is targeted to promote integrating both individual and social learning from individuals to humankind.

2 Aims and objectives

The aim of this paper is to provide a possibility to present and discuss an important social innovation in lifelong learning for sustainable development. Our research group is trying to find partners for research and development, and this seminar is an important opportunity to meet right kind of experts for long term win-win R&D cooperation. CmapTools software will be presented as a free tool and learning environment to monitor and promote learning of natural diversity, environmental education and education for sustainable development.

3 Background

According to its business plan, NatureGate®'s vision and strategy includes long term win-win cooperation with universities and business corporations. The initial funding is promised by the state owned organisations, national and international business corporations. NatureGate® has already close cooperation with ESRI, that is the internationally the leading company in maps, Geographic Information Systems (GIS) and Geographic Positioning Suystem (GPS). Also Nokia will become a business partner. Nokia is interested in mobile identification of plants, and in digital mobile photographing of plants, and natural diversity in general.

Earlier similar efforts like NatureGate® have suffered from shortage or ending of funding or both of them. In NatureGate®, public and corporate funding will be used to start up the main servers. University of Helsinki is becoming a partner in this business company. There are millions of nature lovers and part-time digital photographers around the globe, and their number is rapidly increasing. Eco-tourism, gardening, nature photographing are increasing. They all promote lifelong learning for biodiversity, nature, good environment, sustainable development and good life. Nowadays importance of good life, life well-lived, is understood also in psychological research (e.g. Keyes & Haidt 2003).

Several kinds of formal, non-formal and informal learning and education will be promoted by NatureGate®. Lifelong learning, including biodiversity education, nature studies, environmental education, and education for sustainable development will benefit from NatureGate® in various ways. For example: by having in the WWW, free, systematic, comprehensive, digital collections of high quality photographs and descriptions of flowering plants, and later on other organism and their biotopes, and an easy-to-use, mobile, fast, patented software for identification of plants, and later of other organisms.

There is an urgent need for lifelong learning and better awareness of environment, sustainable development, health and good life. The most important document concerning biodiversity education is The Convention on Biological Diversity, originally signed in Rio de Janeiro Earth Summit in 1992 (CBD, 2007): "Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live." Many organisations try to halt biodiversity loss. One of them is Conservation International (2007) which targets high-biodiversity areas where the needs are greatest and where each conservation dollar spent can save the most species: a) Biodiversity Hotspots, b) High-Biodiversity Wilderness Areas and c) Key Marine Regions. NatureGate® will promote protection f biodiversity everywhere, also in cities, towns, and ordinary countryside, in forests, fields, roadsides etc.

NatureGate® will increase sustainable competitiveness of European Union. Win-win cooperation with many kinds of organisations, including business corporations, will create required resources for maintaining and continual improvement of NatureGate®. NatureGate® will integrate ecologically, economically and socially sustainable development, and it will create enough wealth for continuous spreading and improvement of the networked NatureGate® servers in all main countries and regions. NatureGate® has already good contacts and cooperation with researchers and consultants from many of the leading centers of the world, including Stanford University, Berkeley University, Boston area, Greater

Stockholm area, and Greater London area. This way it will create a global lifelong learning space for biodiversity, nature, good environment, sustainable development and good life.

Free CmapTools software (IHMC 2007) will be used to monitor and promote quality of learning and thinking in relation to biodiversity, natural diversity, environmental education and education for sustainable development. The Finnish National Board of Education has opened a free public CmapTools server for these kinds of activities. CmapTool is very easy to use with all kinds of digital resources, like photographs, maps, video clips etc. by simple drag-and-drop operation.

There are many important and interesting research problems involved in the NatureGate® service: What do people really learn, while using it? What happens in brain, when there are many kinds of sense information available both from nature and from technological tools used? Using design experiments, it may be possible to fond out how to improve the service continually etc.

In the following Figure 1 and Table 1 the main elements of NatureGate® R&D and business program will be presented.

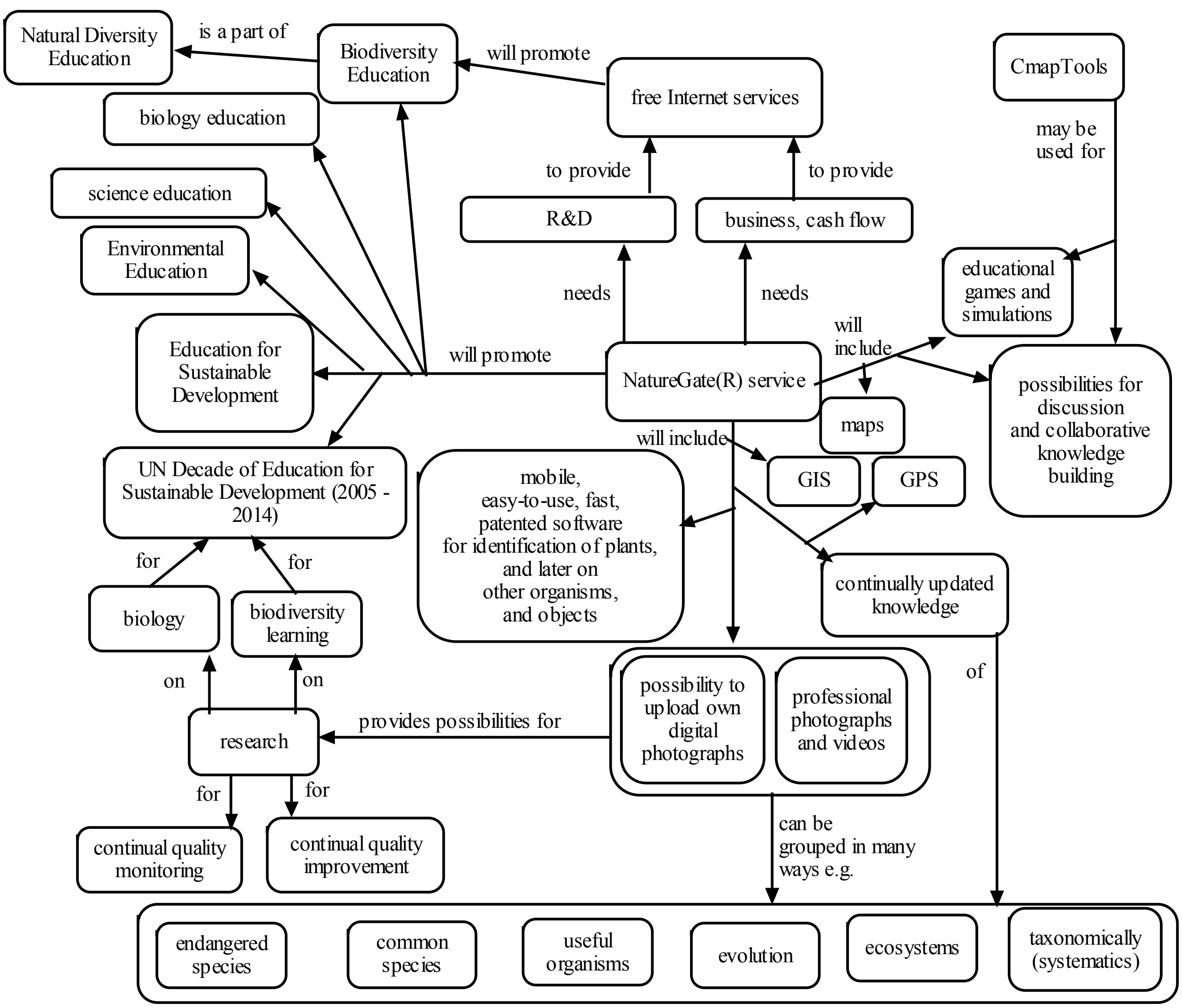

Figure 1.Main elements of NatureGate® R&D and business program. (Adapted from Åhlberg, Lehmuskallio & Lehmuskallio 2006c.)

Table 1. Some of the main content elements of NatureGate® R&D server on three levels.(Adapted from Åhlberg, Lehmuskallio and Lehmuskallio 2006b).

(1) at the organism level	**(2)** at the ecosystem level	**(3)** at the integrating society and humankind level
photographs and videos, texts of **flowering plants, and vascular plants in general,** later on, all organisms. Easy-to-use, fast, patented software for plant species identification.	texts, models, simulations, educational serious games of **ecosystems** and their free services for the whole humankind	sustainable development, UN Decade of Education for **Sustainable development** (2005 – 2014), proposed UN Decade of Biodiversity (2011 – 2020).
refer to	*refer to*	*refer to*
concrete objects	**both concrete and abstract objects,** real ecosystems, the biggest is biosphere itself, can be represented by systems models, **more abstract** than individual species and specimens	**abstract objects** and reasoning of very complex issues and problems of the real world. Involves plenty of high quality learning, thinking, and acting for sustainability, including biodiversity.
in order to	*in order to*	*in order to*
encourage studying, investigations, and inquiries of them **in nature,** outdoors, e.g. taking **digital photographs** and uploading them to NatureGate® server, **promote life long learning.**	**encourage studying,** investigations, and inquiries of them **in nature,** outdoors, e.g. taking **digital photographs and creating** conceptual models, and dynamic models, **promote life long learning.**	**encourage both individual and collaborative knowledge building and acting to promote sustainable development,** including biodiversity, **promote life long learning.**

4 Conclusions

NatureGate® is and will be in accordance with the latest biodiversity research, policy, communication and education. The meeting of the European Platform for Biodiversity Research Strategy (EPBRS) was held under the Finnish Presidency of the EU. The main venue was Hanasaari, near Helsinki, 17.-19. November 2006. NatureGate® principles were presented and discussed first in the e-conference that took place during three weeks, 25. 8. – 13. 9. 2006 (Young, Åhlberg,, Niemelä, Parr, Pauleit & Watt. (Eds.) 2006). Presentation and discussion of NatureGate® continued in the main conference 16. - 19. 11. 2006 (EPBRS. 2006a and 2006b). NatureGate® was well received and it is in accordance with the main resolutions, e.g. Resolution for Biodiversity Research (EPBRS. 2006a) and the main Hanasaari Declaration (EPBRS. 2006b). NatureGate® is and will be in accordance with the latest biodiversity and natural diversity research and education, focusing in enhancement of biodiversity and natural diversity learning. This way it promotes sustainable development, good environment and human well-being.

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Play and Game-Based Learning

Teachers' Expectations of Playful Learning Environments (PLEs)

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This paper reports the expectations of a selection of educators regarding Playful Learning Environments (PLEs). PLEs are outdoor playgrounds designed for learning and growing through play. Pilot PLEs have been constructed in Finland and the concept has been introduced and implemented in other countries. Teachers' views are needed when innovations are to be introduced in the schools. Teachers (N = 14) from pre-primary education to the fourth grade were interviewed to ascertain their preferred practices and expectations of teaching, playing, and learning where PLEs were concerned. The grounded theory approach was used in coding and theory building.

The teachers' expectations concerning PLEs are related to implementation, play, learning, curriculum, and concerns. *Implementation* means that a PLE provides alternative learning environments for teaching and learning. *Play* refers to an imaginary context that facilitates and inspires playing at school. *Learning* is related to the emotional, physical, social, and cognitive benefits that activities in a PLE can bring. PLEs are expected to afford a more flexible adaptation to the *curriculum*. Finally, *concerns* describe critical views, which have to be considered as well. There are critical opinions about whether PLEs are really needed or merit further investment.

On the whole, the teachers' expectations relate to *teachability, playability*, and *learnability*, which are discussed in the article. Teachers, teacher educators, PLE designers and manufacturers have insights to gain from this study. In addition, teacher's views are essential in designing pedagogically meaningful contents for PLEs and in developing PLEs that meet the challenges of the future school.

Keywords: Teachers, playful learning environment (PLE), playful learning process (PLP), play, learning, teachability, playability, learnability

1 Introduction

Teachers are in a key position in developing the potential for learning and in adapting innovations to school practices (Dunn, 2004; Veen & Vrakking, 2006) and their views should be recorded. This article reports the outcomes of a study focusing on teachers' views and expectations of Playful Learning Environments (PLEs).

A PLE is an outdoor playground designed for playing and learning in the school context (Hyvönen et al., 2006). Information and communications technology (ICT) is implemented in the construction, allowing children to play and act without portable devices. Pilot PLEs have been constructed in Finland and the concept has been introduced and implemented in other countries. Although playful environments (Decortis & Rizzo, 2002), mobile outdoor games (Verhaegh et al., 2006), and learning through play in ICT-based environments have been studied recently (Price et al., 2003; Kennewell & Morgan, 2006), the research has not focused on settings, users, and goals similar to those that apply in the case of PLEs. Settings refer to outdoor learning environments where learning and growing take place using the whole body rather than at a desk. The primary users in the case of PLEs are children and teachers in formal, curriculum-based education, but use in informal learning is also possible. The goals associated with PLEs are multifaceted, with learning and growing in play and games being uppermost them. Learning is viewed as a set of physical, cognitional,

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emotional, social and cultural processes (Hyvönen & Kangas, accepted), and the socio-cultural perspective (Vygotsky, 1978; Säljö, 2001; Bodrova & Leong, 2001) is highlighted.

Educational use of PLEs should, however, be considered against teachers' and parents' perceptions of children and their experiences of today's school. Children require new approaches and teaching and learning methods in order to keep up their motivation and attention. Teachers have noticed that children growing up in a digital world cannot, for example, concentrate or listen for more than five minutes in the classroom. Parents are worried, because children pass their time mainly by sitting at a computer and in front of a television. Parents urge their children to play outdoors, meet friends and engage in sports (Veen & Vrakking, 2006). Computers and television are not the only reasons for decreased outdoor play; some children choose not to play outdoors. City planners, too, are responsible, because in certain metropolises, there is no place for outdoor play (Clements, 2004). The PLE has the potential to address these obvious shortcomings.

Schools should be considered as public places that bring children together and provide shared activities and common ground for collaborative play (Loukaitoi-Sideris, 2003). Today's children spend less time playing with their peers, and play in educational settings is pitted against increased academic content and goals. Educators replace play with more academic activities, because they see play occurring on an immature level in the classrooms (Bodrova & Leong, 2003a). The goal of the PLE is to overcome these problems: the PLE and its use would probably increase play with peers and high-quality play in the school. Teacher's expectations of such an environment are crucial in assessing its potential.

2 Aims, objectives and research question

The aim of this study was to ascertain what expectations teachers have of outdoor learning environments, its technological possibilities and its use in the school context. The objective was to understand the contextual requirements for innovation from the educator's perspective. The research question addressed is the following: *What expectations do teachers have of a playful learning environment?*

3 Methods

Teachers (N = 14), aged 25 to 53, from pre-primary education to the fourth grade were interviewed regarding their preferred practices and expectations of teaching, playing, and learning in two pilot PLEs. The schools were chosen randomly and teachers were asked to take part in the research. Jane, Rita, Mark and Sally worked in pre-primary education, Kate and Liv in the first grade, Pauline, Mary, Gary, Alice and Lisa in the second, John and Kim in the third, and Ann in the fourth. Most of them had previously taught fifth and sixth grade as well. The age of the pupils ranged from six to twelve years.

The teachers have specialised widely, in such disciplines as primary teaching, social sciences, languages, special education, music, Finnish, presentation skills, physical education and handicraft. The teachers in the cities of Oulu and Rovaniemi in northern Finland were told that their views would be used for developing outdoor learning environments and the content of the activities organised there. The teachers' statements were based on their previous experiences of teaching, an example of a playful learning process (PLP) (Hyvönen et al., 2006; Kangas et al., accepted) where the curricular topic was "weather", and simplified graphical pictures of ten different pieces of PLE equipment (Figure 1). Thus the interviewees never saw the actual equipment.

Figure 1. Examples of the PLE equipment: info station, wave platform, stepping stones and scales

Each piece of equipment was described briefly. The info station includes a computer and the related software. Users can choose games, and get instructions from the station's screen. The wave platform makes waves by users and tests balancing skills. Stepping stones are functional as connectors and routes in play and games and scales can be used for comparing weights. Teachers were told that it was possible to use RFID (Radio Frequency Identification Device) technology and digital technology or that the PLE could be provided without any technology. They were asked to consider the PLE from an educator's perspective but they first took into account children's expected experiences.

The interviews were carried out according to a five-theme plan. The themes were 1) playing and learning in the school context, 2) PLE equipments, 3) activities in the PLE, 4) information and communication technology, and 5) the teacher's role. Each interview lasted from 40 minutes to two hours and was recorded and transcribed. The data corpus was coded and analysed (Figure 2) using N*Vivo qualitative software, designed for the grounded theory approach (Glaser, 1978; Strauss & Corbin, 1998). In coding I considered only those utterances that concerned wishes, needs, fears, expectations, suppositions, evaluations, estimations and motivations and arguments for the PLE, its use and technology. The teachers were given an opportunity to read this article in order to ensure the validity of the research.

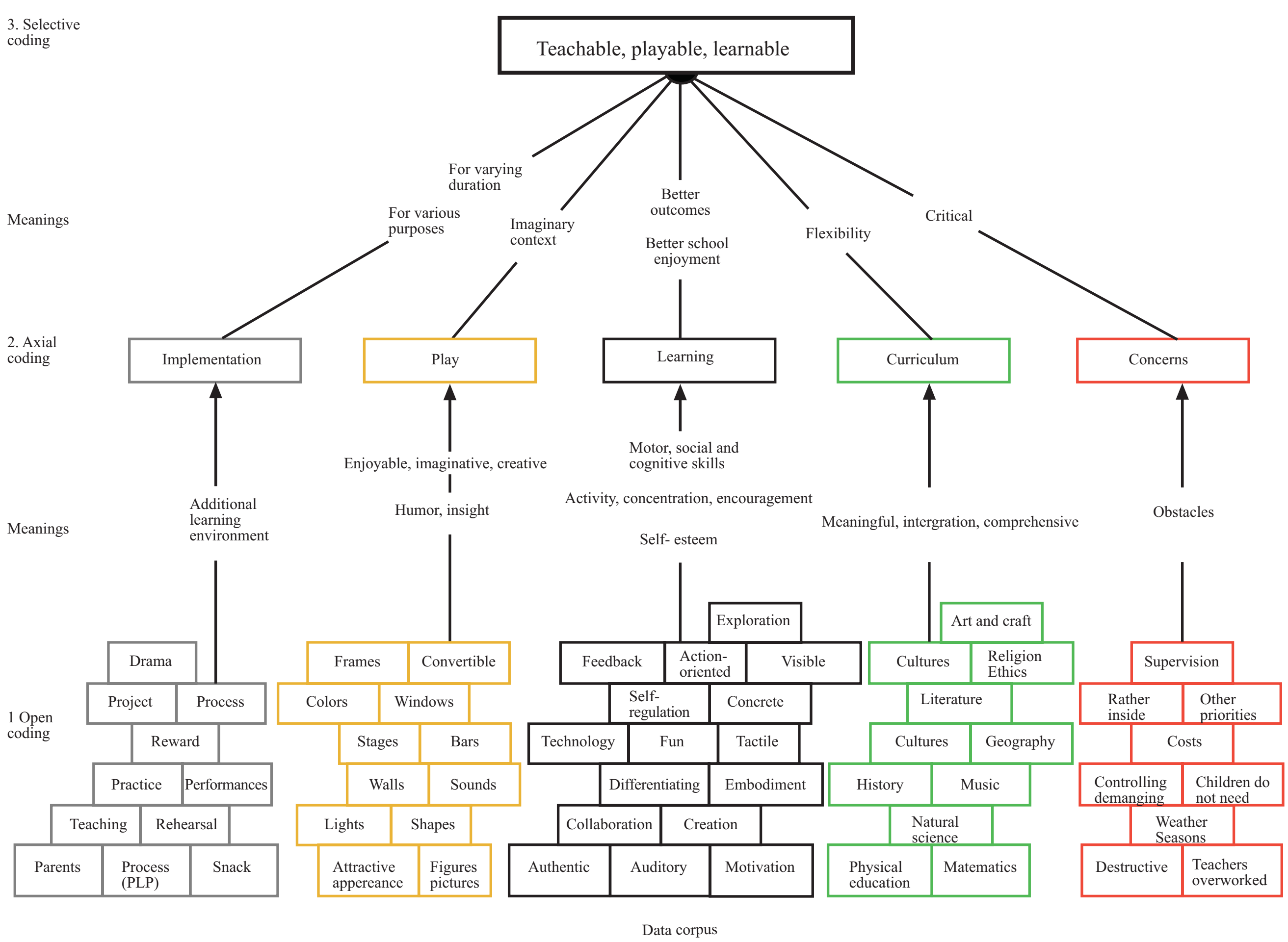

Figure 2. Coding process and categories used in this study

Through constant and systematic comparison, the open coding resulted in over sixty concepts, which are illustrated in the figure above. The open coding concepts are five different axial concepts. Each of these five concepts - implementation, play, learning, curriculum and concerns - is related to the playful learning environment, the activities in which are expected to be teachable, playable and learnable. These three aspects of learning are the core concepts of the selective coding.

5 Results

In the results section, I precede bottom-up, in keeping with the coding process (Figure 2). First I clarify teachers' expectations (open and axial coding) and then elaborate them in terms of teachability, playability and learnability (selective coding).

5.1 Teacher's expectations of the PLE

When teachers clarified their expectations of the PLE, they pondered the question, how would I use the PLE? Their expectations indicated five main dimensions: implementation, play, learning, curriculum and concerns. Implementation refers to how daily practices would be carried on using the PLE.

5.1.1 Implementation

The teachers expected that they would be able to carry out teaching and learning processes as longitudinal processes and projects, as brief "snacks" or rewards, as performances, and as practices dealing with something that has not yet been learned. The teachers planned various plays and performances – even a rock concert with a real screen. The PLE affords some ready-tailored games and game concepts. One is a mathematical game entitled "Space Treasure", which was designed exclusively for the wave platform and has been tested by school children (Kangas et al., accepted). In addition to ready-made games, teachers, need handy tools for adapting games and developing new games and tasks for the different PLE facilities.

Playful learning processes (PLP) (Hyvönen et al., 2006; Kangas et al., accepted) are considered the most meaningful ones in implementing a PLE. They comprise three phases: orientation, playing, and elaboration. In *orientation*, a common ground (Mercer, 2000) is provided and a framework is designed for the process. Teachers and children together formulate the dimensions, content, roles and rules in keeping with the chosen theme (Broström, 1996; Bodrova & Leong, 2001). During the *playing* phase, children deal with learnable issues. They use their imagination, creativity and their entire bodies and also negotiate and collaborate with each other (Hyvönen & Ruokamo, 2005). The *elaboration* phase brings the process together in a creative manner (see Loveless et al., 2006).

Implementation highlights the value of an additional learning environment – an outdoor one –which has the potential to involve parents as well. Jane said that she would invite parents and let the children show how they can use the PLE and what they have learned. This would be one way to make activities and learning visible. The parents would be astonished at how capable their children are, Jane assured.

5.1.2 Play

The teachers expected that certain features of the PLE would provide enjoyment, happy feelings, humour, insight, imagination, and creativity through various forms of play. For instance, windows, different forms, stages, bars, lights, spaces, colours, sounds, shadows, and walls which the children can draw on are important.

The PLE was expected to include maps, which would provide imaginary play and various adventures with a possibility to learn about subjects such as geography, cultures, religions, languages and people's life locally and globally. Kate laughed, saying: --- *if a child tripped on the peak of the Kilimandjaro, he/she would remember that mountain always.* Maps and map banks used in conjunction with the PLE would also provide playful ways to do orienteering, one use which the second-grade teachers anticipated.

Teachers shared the expectation that the versatility of the equipment and the possibility to imagine and manipulate the environment in diverse ways would afford play and games as well as interaction with peers and the environment (see Price & Rogers, 2003).

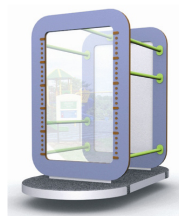

Figure 3. Drawing walls

For instance Liv considered the PLE equipment in light of playing and noticed that drawing walls (Figure 3), which include three different surfaces for drawing on and bars for climbing and hanging props, would be functional in various ways. She would use the walls for ethical, ethnic and religious contexts and to increase acceptance towards "others": --- *people look different and they are different, so with drawing walls play can be created where humanity and diversity are handled in an appropriate and playful way.* Kim expected that drawing walls and music would provide musical painting in which emotions are expressed visually. The teachers would like what is drawn and written to be captured in digital form for further use later in the classroom.

The body, its proportions, perception and use are also dealt with in the school, with appropriate exercises, and educators therefore expect play in the PLE to provide more possibilities for that purpose. The jungle gym (Figure 4) inspired pre-primary teachers to ideate some play choices.

Figure 4. Jungle gym

The first idea in using the jungle gym was to use cards with creatures posing in different positions. Children are supposed to pose in positions similar to those of the creature on the card, not on the ground, but in the frame. They need to concretise spatial dimensions using their bodies. Advanced or older children may tutor younger ones to help them find the correct position. In the activity children pose in various positions, for instance, hanging upside down. The goal may be to create a certain form, such as triangle, or even a three-dimensional figure. They take digital photos of each position and go on to create a work of art. Another idea is to play "shadow theatre", which requires a white large curtain and strong light. Children's bodies and positions are reflected on the curtain, so they can play bats or act out whatever adventures they like as shadow figures.

Photographing, voice or video recording should be a natural part of playing. Pauline emphasised that a photographer should be allowed to make his/her own decisions - in zooming, cropping and shooting angle - and children should have the opportunity to use cameras in different situations (see Decortis & Rizzo, 2002). It is both amusing and important for children to use real cameras. Kate expected that if they were studying history through a playful learning process, someone would be pretend to be a smith. The smith would talk accordingly, telling about his or her work and life in that particular era. The speech and the sounds of the smithy would be recorded and used in the elaboration phase. Decortis and Rizzo (2002) used sounds in a quite comparable way to enrich children's narratives, for instance, as soundscapes. In the PLE, sounds would be recorded on the "stage" (Figure 5), which one teacher suggested could be thought of as a forge.

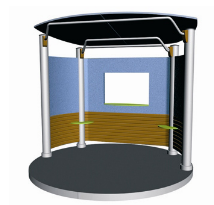

Figure 5. A stage

The stage would be used for various imaginative purposes - such as a store, kiosk, television, and home, stage for performances and drama, and place for baking real waffles. The teachers assumed that a stage would be fruitful in integrating educational goals, play and fun. All in all, they saw play as involving joy, imagination, creation and insight.

5.1.3 Learning

The PLE and its related technical adaptations – the possibility to move and to be active instead of being seated – are expected to enhance learning. The PLE is considered a tool (Vygotsky, 1978, Säljö, 2001; Bodrova & Leong, 2001) useful for activities and meaning making (Jonassen, 2002). The most strongly emphasised thoughts pertained to embodiment, motivation, feedback, collaboration, and individual needs.

Embodiment refers to the use of the whole body for learning, which is not afforded in the classroom. It helps children understand abstract concepts, such as mathematical correlations, physical phenomena, and musical qualities. Teachers supposed that the PLE is *motivating* and interesting in itself and, if enhanced with ICT, even more attractive. Feedback, which gives guidance about ongoing activities, is considered significant for learning processes. Guiding feedback, however, means that two-dimensional (right–wrong) feedback is not enough and that more information is needed. *Feedback* may be expressed in the form of words, sounds, lights, texts, or combinations of these. Kate suggested various playful learning processes that could be implemented in the PLE, one of which involved music, embodiment and feedback (Figure 6)

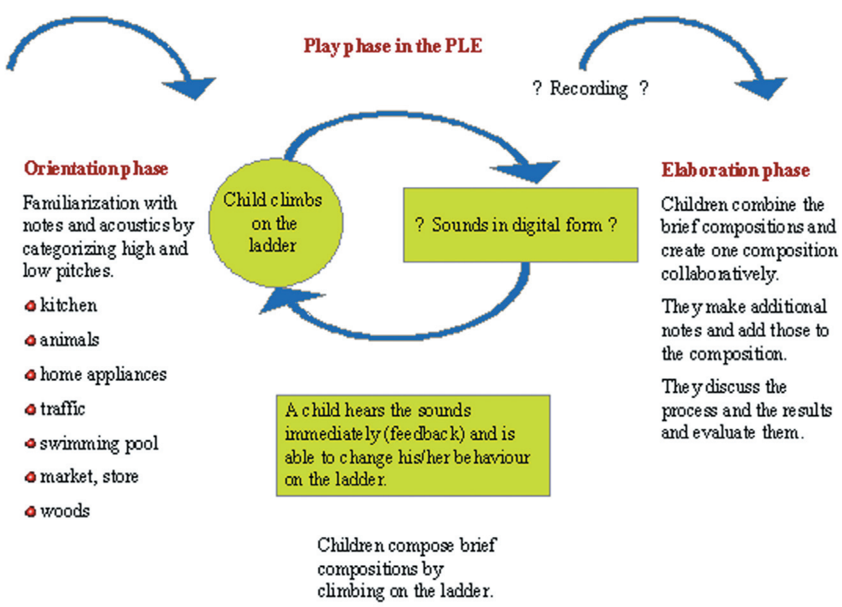

Figure 6. Teachers' expectations of the playful learning process

Figure 6 illustrates Kate's expectations concerning music and the PLE. In the first phase, *orientation*, children practice listening to sounds from different sources and in different environments and to evaluate pitch and probably rhythms as well. The *play phase* in this example requires that the PLE include a ladder that plays different sounds, corresponding to piano keys, when a child climbs on the rungs. The higher the child climbs, the higher the pitch is. Kate supposed that ladder rungs would be better than piano keys one could step on, because a vertical structure concretises music better than a horizontal one. Adapting Price et al. (2003), the rungs would represent 'tangibles', which are physical artefacts that are electronically augmented and enhanced to trigger digital events. Tangibles have potential for providing innovative ways for children to play and learn (Price et al., 2003). This is manifested in Kate's expectation as well: children experience sounds concretely through their bodies and as a result of their actions and receive immediate feedback from the environment. Finally, children record brief compositions, which can be listened to and further developed in the classroom in the elaboration phase. As noted by Jonassen (2002), creating a piece of music while at play, in interaction with the environment, signifies meaning-making for children,

The entire process is discussed and evaluated during the *elaboration phase*. Children use the material that they have collected during previous phases (compositions) collaboratively and creatively.

This is a perfect example of the information transformation model, presented by Rogers et al. (2002). The model describes variations of activity and related physical and digital representations. When physical actions (climbing) are followed by digital representations (sounds), and children get immediate feedback, meaningful opportunities to explore and probe, insights between various options in play are afforded (Rogers et al., 2002). Minimal composing provides possibilities to imagine and externalise musical sounds in pitch and rhythm. The technology is a vehicle to explore musical ideas and concepts which might otherwise be beyond children's reach (Jennings, 2005). Ann concluded that technologies are tools that further so-called higher goals in learning and growing. The PLE and its technologies together should afford more authenticity and concrete representation than the indoor classroom environment.

An outdoor play environment and playful learning processes are expected to foster *collaborative* play and peer tutoring. John, for instance, believes that musical notes could be drawn on the wall and the sounds could be heard in the info station. One child could place the notes on the staffs and another could try to recognise the tune at the info station using a headset, or the other way round. This activity would also entail externalisation of musical sounds (Jennings, 2005).

Although the benefits of collaboration are emphasised, *individual needs* should be met better by using a PLE rather than the classroom. Some children need more concretising, some more practice, and some more advanced challenges to keep up their motivation. Pre-primary educators are concerned about the increasing number of children with special needs, whereby they would like to see devices provided in the PLE for pronunciation practice. All the children would benefit from it. Mark gave a detailed example of a suitable playful apparatus with a model, mirror, microphone and animation. Goals for physical learning were also mentioned, because today's children do not know how to handle a ball or how to do a somersault; some need courage to use their bodies and some need balancing exercises.

On the whole, educators' expectations pertained to increased motor, social and cognitive skills, meaning that children would be more active physically, concentrate better on tasks and play, and receive more encouragement. In addition, better self-esteem may be achieved which in turn addresses individual needs.

5.1.4 Curriculum

The national curriculum is considered to be challenging in relation to the time available to teach it (Hyvönen, submitted). Kim said with regret: the goals and contents are so extensive that we must simply work very hard to achieve them. *The outcome – for instance in mathematics – is that only those children who are advance, have time for thinking, reasoning and problem solving. With others we have to settle for teaching the basics.* According to the teachers, play and the PLE should progress to meet curricular goals; thus the idea of playful learning process is beneficial. Educators expect to get some ready-tailored models of PLPs which they can further adapt for their own purposes. Integration of subjects is desirable and seen as uncomplicated in the PLE, and the environment also permits more flexible timetables.

Subjects that can be fruitfully learned through play include mathematics, physical education, natural sciences, languages, religions and geography among others. Mathematics seems to be a particularly rewarding case, because learning it (e.g. multiplication) requires a lot of practice and repetition and takes time. However, the strongest expectations regarding the PLE lie in the area of music education. ICT, accompanied with embodiment, is expected to make musical connections tangible, comprehensible, and motivating, providing pupils with a chance to do some composing as well (see Jennings, 2005). All in all, expectations considering the curriculum signify meaningful ways to pursue educational objectives by integrating subjects and providing a widened scope for action and a comprehensive perspective.

5.1.5 Concerns

The criticism provided by the teachers interviewed reveals their negative expectations concerning the PLE. One of their main misgivings is whether children need new structures or sophisticated technical adaptations at all. Some teachers would like to see children playing with non-commercial toys and equipment and thus prolong as authentic a childhood as possible (see Postman, 1984). Reluctance to embrace PLEs is also understandable in light of the image of a new generation, called Homo zappiens. Homo zappiens operates in a global cyberculture, relying on multimedia and technologies, which radically change his/her behaviour and thinking (Veen & Vrakking, 2006).

Considerations of the PLE and its use prompted concerns that teachers would become overloaded; some teachers were hesitant because the PLE involves more responsibilities and requires novel technological skills. Teachers are also afraid of violence in that young people may destroy valuable equipment during evenings and weekends and cause large financial losses and a great deal of distress. In addition, there are other preferences for outdoor equipment, such as swings and climbing bars. Teachers also suspect that novel outdoor equipment is excessively costly. One further problem relates to legislation: teachers are not allowed to leave the children outdoors without a supervising adult, so they would need an assistant. Yet another concern is the weather and the seasons in Finland; in particular, snow and cold are expected to create problems with using PLEs in the wintertime, because shelters would have to be provided. The criticism indicates that there are obstacles to the use of PLEs and the related technology.

5.2 Teachability, playability and learnability

The teachers expect *implementation* to result in an additional learning environment that affords activities for various purposes and durations. With play they refer to imaginary contexts that facilitate and inspire playing at school. They relate *learning* to the emotional, social, and cognitive benefits that activities in the PLE can provide. Technological tools are expected to make learning more playful, visible and efficient. The teachers expect the PLE to adapt more flexibly to the *curriculum.* There are also concerns regarding the PLE. Some doubt whether the PLE is necessary and worth further investment. The concerns are seen either as obstacles that hinder the PLE or as problems that must be overcome On the whole, the teachers' expectations support a learning environment that can provide *teachability* (implementation, curriculum and concerns), *playability* (play), and *learnability* (learning). Teachability, playability and learnability are overlapping, closely related concepts.

5.2.1 Teachability

Teachability emphasises the teacher's work. Teachers have to learn first how to use the PLE, how to integrate play and learning into curriculum-based education and, finally, how to ensure learning and growth. Use of the PLE and trust in the children appeared to be relevant factors in teachability.

Use of the PLE

Learning to use the PLE worried some teachers. They complained about their lack of creativity, but the real question may be one of creative satisfaction. It derives from meeting external challenges or inner needs to capture and express something through artwork (Claxton et al., 2006), in this case exploiting the PLE in creative ways and evoking "higher goals" in teaching. How *intuitively and consistently* the PLE can be used, how well matched to the task it is and whether a help desk of some kind is available are properties of learnability put forward by Laakkonen and Isomäki (2005). Teachers found pictures without any explanation astonishing; as Kim said, *these look so modern and really fascinating, but how do you use them?* For instance, the appearance of a spinning mill or ball toss (Figure 7) did not provide information about their use, but after a brief explanation teachers found a number of ways to use them in play and learning.

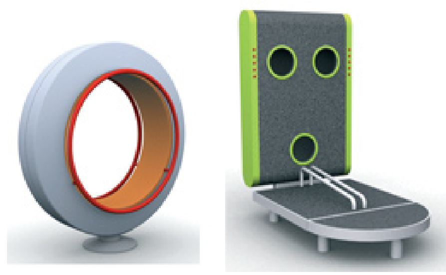

Figure 7. Spinning mill and ball toss

The spinning mill is also called a somersault device. A person, child or adult, gets inside the ring, which is rotating. Another person is needed to spin the inner circle. The ball toss has three holes, two for the ball to go in, and one for it to come out. Red lights on either side inform the user about hits.

One indicator of teachability is expected *frequency of use.* In pre-primary education, the PLE could be used once a week for framed processes, and daily for non-structured play. Some teachers estimated that they would use the PLE only a couple of times during one semester, some every other day. Most of the teachers expected to use the PLE every week, depending on the weather conditions, current learning goals and the availability of PLP models. Kim thought: *it would be marvellous to use PLEs for theme days, or to divide the activities over several days. The children would like them and remember them for a long time.* The PLE would provide an alternative learning environment that would remedy shortcomings related to the classroom and in this way provide more teachability. The informants found a wide variety of ways to use the PLE and some were really enthusiastic. As Liv exclaimed: *I could find so many ways to use these!*

Trusting

When considering teachability, the children are important. Teachers are willing to rely on and trust them to a considerable extent, because they can assist or even tutor teachers and peers. Children are valued as very creative and clever and are assumed to know how to use the PLE and its technologies. In this respect, teachers saw slight, but noteworthy correlations with the image of Homo zappiens, as described by Veen and Vrakking (2006). Trust is also one of the seven pedagogical principles that the authors of Homo zappiens suggested for the educators of tomorrow. The other principles are talent, challenge, immersion, passion and self-direction; these are all essential to the school of the future.

Trust is viewed in broad terms, the major focus of the concept being confidence that children will learn. Traditional education is more a system of mistrust that relies on control. In innovative schools, children are seen as being driven by intrinsic motivation (Veen & Vrakking, 2006). Trust was discussed by the teachers from one related perspective: Kim and Lisa discussed how difficult it is to trust that children *will learn in play,* because the cultural tradition emphasises desk-based paper-and-pencil work as "real" learning. Kim concluded: *we should just trust in other activities than the traditional ones to provide learning.*

Although concerns and criticism regarding the PLE and its technologies were voiced and demands for proper introduction of and models for PLPs were expressed, the teachers innovatively and creatively discovered ways to implement teaching, playing and learning using the alternative learning environment and found it advantageous and fun. The following conclusions can be out forward where teachability is concerned:

1) Teachability refers to learning to use the PLE, to implementing teaching, playing and learning in curriculum-based education, and to providing learning and growing for children.
2) Most teachers are willing to design and use the PLE for play and learning. Frequency of use depends on various factors, but a general estimate of once a week would be reasonable.
3) All the teachers expect to get examples of playful learning processes as well as an efficient demonstration of the use of the PLE.
4) Children are trusted as PLE users, and are expected to augment teachability.
5) The PLE provides alternative learning environments for carrying out teaching.

5.2.2 Playability

Playability refers to a quality of children's that engages their interest and involves them, fostering learning and growing. The quality is defined in terms of playfulness, which takes into account the goals of education and mature play. Mature play is not repetitive or unimaginative; rather, it is complex and contributes to children's learning and development in many areas (Bodrova & Leong, 2003a; b; Hyvönen & Ruokamo, 2005). The key factors for playability proved to be the availability of a medium for play, a multipurpose environment and authenticity.

Medium for play
Children's development in many areas could be enhanced by the PLE. The greatest advantage is that the PLE provides a medium for physical activities, collaboration, imagination, and the use of whole body that are not available to the same extent in the classroom. Planning play, play itself and physical activities in play are fun for children. As John illustrated: I'm sure that I would never need to ask them twice, if one of these (a PLE) were in our schoolyard.

Multipurpose environment
With regard to playability, educators value an environment that is not designed only for certain purposes but can be adjusted for various imaginative situations. One example of a multipurpose prop (Bodrova & Leong, 2003b) is an exploration unit (Figure 8).

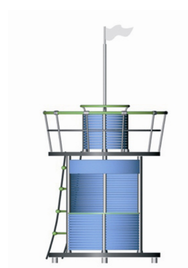

Figure 8. Exploration unit

The exploration unit is high, there is space inside, and it is equipped with various gauges and instruments: it inspires children to explore, wonder and gain insights and it can represent a boat, a mountain, Noah's ark, a castle, a submarine, a space shuttle, a cave or a forge, etc.

Authenticity
Authenticity makes playing more meaningful for children; therefore the microscope, rudder, telescope, compass and thermometer that are part of the exploration unit have an important role in play. However, when the children study leaves, mushrooms, birds, snails and insects, the teachers would like to have the chance to keep a digital record, or "discovery diary" of their perceptions. In addition, playability would be enhanced if PLEs were interconnected. Children could play the same game with children in their twin cities. The following conclusions can be put forward where playability is concerned:

1) Playability refers to children being involved in play and to providing mature play that can contribute to learning and growing.
2) A PLE provides a medium for play and physical activities; play and imaginary situations can be varied.
3) Playing in a PLE is fun that is expected to provide school enjoyment.
4) The equipment in the PLE is fascinating and motivates children to play.
5) Play affords increased collaboration locally with peers and globally with children from other schools

5.2.3 Learnability

Learnability is related to the question of what factors promote learning or remove obstacles to learning in the PLE. This data indicate that teachers set high expectations for learning, especially learning meaningfully and enjoying school. Learnability is reflected in a holistic basis for learning, embodiment, collaboration, and tutoring.

Holistic basis
The holistic basis that underlies the PLE ideology was valued as regards teachability and learnability. Indeed, the PLE teaching and learning activities are not divided up into single lessons and single subjects, but are logically integrated as holistic processes. Holistic processes include a "red thread", which means a narrative or plot where learnable issues, or "elements", are connected together (see Crossley, 2003). During orientation, playing and the elaboration process, children and teachers can together construct a logical entity, a narrative. The process is cognitive, social, emotional and physical (see Decortis & Rizzo, 2002; Crossley, 2003). The plotted entity that they construct is not a verbal production only but constitutes various means of expressions (Decortis & Rizzo, 2002), including *visual and aural information* collected from the play processes.

Embodiment
Embodiment includes emotions, action and concretisation, was the most frequently discussed factor. The concept of embodiment posits that learning does not take place merely in the head, but in the whole body (Burkitt, 1999; Jonassen, 2002). Children use their hands, legs and trunk to perceive, discover and understand; they invest emotions in activities and interact verbally and bodily with each other. Embodiment can be considered in two ways: using the body as a tool, with the whole body used for reasoning and remembering (Norman, 1994) and by extending a body with different tools (Hirose, 2002). The tools, such as tangible rungs of a ladder, are extensions of the body in the processes of perception and action. However, the boundaries of the body become vaguer, because perception and acting capabilities may extend from the PLE to a classroom by using detached technologies, for instance digital video clips or digital images. As Hirose (2002, 296) describes it: *detached objects become part of the body–an extension of perception-action system.* However, the body is not the same all the time; it changes due to learning and development. When considering learning, it is important to consider how body-extending tools are used (Hirose, 2002; Säljö, 2004).

Emotions must be considered in learning from the point of view of Homo zappiens, who are dissatisfied with "chalk and talk" classrooms due to the lack of action, freedom, media, networks or immersion. They feel forced to be passive (Veen & Vrakking, 2006). Educators in this study expect that the PLE would inspire children to action, responsibility and, to some extent, the use of media. The feeling of *authenticity* and *concretisation* and *action* are also crucial in learnability. The PLE and playful learning processes provide children with an opportunity to take part in content planning, to have a more active role in their learning and to be real actors in playing. Action is also a way to concretise. Physical activity is important for all, but especially for those who do not benefit from classroom routines and who suffer from restless behaviour.

Collaboration
Collaboration and peer tutoring are components of learnability. In the PLE children get opportunities to plan play frames and processes (Boström, 1996; Bodrova & Leong, 2003), play collaboratively and help each other. Another question is how to sustain collaborative learning activities in the PLE. In this respect, I agree with Hännikäinen and Oers (2001), who propose that more serious attention should be paid to the affective aspects of collaborative learning activities.

Tutoring
Tutoring includes guiding and feedback and the transparency of these processes. With proper tutoring facilities children would be active content producers and the PLE and its technology would in many ways be important as tools for learning (Vygotsky, 1978; Säljö, 2001). The tools help children think and analyse their own experiences and to construct a narrative entity in a creative process (Decortis & Rizzo, 2002); the tools also make the process visible, even tangible. The PLE is expected to tutor its users in order to provide learning. For instance the info station would give spoken instructions as well as the cues and codes children need in play in a way that the children can understand them. Written instructions are not suitable for children who do not read yet. According to a usability study conducted with children, words, if used, should be easy to read and understand. Visual cues should be provided to get things started and the provision of reading aids and animations as separate visual elements also helps children (Kähkönen & Ovaska, 2006). Guidance, just-in-time feedback that directs children's attention to ongoing activities, would support learning dramatically. If technological solutions were not available, it is the teacher's duty to provide similar feedback. PLEs and technologies would change the teachers' role - but not its significance - in children's learning and growing (see Hyvönen, 2007).

With regard to learnability, the following conclusions can be presented:

1) Child-initiated factors that promote learning or removes obstacles for learning in the PLE are embodiment, emotions, activity and collaboration including peer-tutoring.
2) Teacher-initiated factors that promote learning or remove obstacles for learning in the PLE are comprehensiveness, i.e., integration of school subjects and playful learning processes.
3) Environment-initiated factors that promote learning or removes obstacles for learning in the PLE are making activities, processes and results visible, audible and tangible, providing guidance in playing and learning processes and adapting the environment to the needs of different players and learners.

6 Conclusions and implications

This article has focused on revealing teacher's views and expectations of the playful learning environment, its use and technologies. It is not particularly surprising, that educators' expectations relate to teachability, playability and learnability. The pre-primary and basic school educators would welcome an outdoor learning environment and they regard it mostly from children's perspective. One reason for this point of view is that the PLE is expected to get children motivated in activities, act collaboratively, enjoy and feel good at school, which is not always obvious today. As Veen and Vrakking (2006) mention, the children, their culture and their behaviour and cognitive processes have changed but the school has not responded to these changes.

Teachers need to respond to these changes as well. Playfulness as a personal trait is characteristic of teachers, who come up with innovations and use them readily in teaching like any other tools available in the school. Playfulness correlates strongly with features of innovation, creation and courage (Dunn, 2004). In other words, creative persons have a playful approach to solutions and always look for new angles and affordances (Glaxton et al., 2006). Although teachers in this study proved to be playful for the most part, many teachers are not, finding it good and secure to adhere to familiar routines (Dunn, 2004). This should be kept in mind in evaluating teachability in the context of PLEs and technologies. Therefore, instead of considering the effectiveness of the system, the emphasis should be on supportive manners, on the user's experiences (Laakkonen & Isomäki, 2005), and determining how satisfied users are when starting to use the PLE and implementing teaching and learning processes.

Technologies change the way we act and learn (Säljö, 2004; Veen & Vrakking, 2006) and PLEs will reshape the future of learning and the culture of playing. Although technologies are important and needed, and the PLE is assumed to be powerful, they will not improve learning in any linear sense. What is important in the current context is how teachers and children engage in activities and how they use the environment or technologies. Technologies and environments, like other tools, are sometimes productive, but sometimes rather useless (Säljö, 2004). How usable and learnable the PLE is, however, should be evaluated in practice. Tentative studies and assessment have already been done, in which the goal was to find ways to increase physical activity in the form of games in the school context. The study demonstrates that the outdoor PLE can be used successfully for that purpose. (Kangas, et al., accepted)

The view brought to light in this study is both positive and challenging. Teacher's expectations relate to a vision of playful learning as Price et al. (2003) see it: (informational) artefacts involve fun, and the boundaries between play and learning get blurred. The teachers' views and expectations of the PLE are essential in order to identify the requirements that educators set for the PLE. In addition, their views are needed in designing pedagogically meaningful content for PLEs and in developing PLP that meet the challenges of the future school. Future research will investigate teachers' expectations to determine how closely they correspond to reality and how their experiences with actual PLEs correlate with the concepts of teachability, playability and learnability. In addition, more emphasis should be put on collaboration and peer culture and the Homo zappiens that challenge traditional educational systems. *If education has always been about preparing individuals for their role in society* (Veen & Vrakking, 2006, 121), we should critically consider society and ask what kinds of roles are needed there.

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During Let's Play project (2003–2006) in cooperation with the Smartus team [http://www.smartus.fi]

Space Treasure Outdoor Game in the Playful Learning Environment: Experiences and Assessment

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This paper examines the Space Treasure outdoor game as part of the innovative Playful Learning Environment (PLE). The Space Treasure game was designed for educational contexts with an aim to increase children's physical activity and to enable learning through play in an informal setting. The game concept was planned for one playground device, the wave platform within the PLE. The basic idea of the game is to move on the platform by making mathematical calculations in the imaginative frame of a space theme. The aim of the study was to test the game in its natural context – within the PLE in a school yard – and to evaluate it through the socio-cultural framework and through the concepts of playability, enjoyability, usability, and learnability. Thus, the theoretical background of the study involves a transdisciplinary approach to examine a novel game concept designed for schoolchildren. Children (N = 18), aged 10 to 12 years took part in the tests by playing the game in groups of 3 to 4 children. The technological properties were tested only through simulations. The playing was videotaped and the children were interviewed after the playing. The results reveal that children by and large enjoyed the game and gave creative suggestions for making variations of it. According to the results also social collaboration seemed to have been fruitful during game sessions. Games that promote meaningful learning are valuable because a "new generation" is emerging, demanding new teaching and learning methods. Therefore, this study is important for educators and researches as well as those who develop game and outdoor learning environment.

Keywords: Game, Playful Learning Environment (PLE), playful learning, playability, enjoyability, usability, learnability

1 Introduction

Children are becoming skilful technology users in today's society, but their physical activities are quite limited due to desk-bound activities in schools and at computers and consoles. Meanwhile, the impact of the outdoor learning

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environment on children's play has received increased attention (Barbour, 1999; Clements, 2004; Lindstrand, 2005). However, outdoor play is a minimized aspect in education, and even more so in the context of learning through play in particular (Lindstrand, 2005). This paper reports the outcomes of a study focusing on the innovative outdoor learning environment intertwined with learning through play and game. This setting was made possible by the Let's Play project (2003–2006), in which we had an opportunity to take part in planning and designing a novel playground with technological tools and *playful learning* activities. We had a chance to develop, for instance, digital games and curriculum-based contents for the playground that we designated as the Playful Learning Environment (PLE) (e.g. Hyvönen et al., 2006; Hyvönen & Kangas, to appear). The PLE was designed for use in the school environment, and unlike desk-bound activities it affords various bodily activities in playing and learning.

The aim of this study was to investigate the use of the playful learning environment in curriculum-based education. In particular, the objective was to examine a game concept on the playground by testing it with schoolchildren and by assessing it from the following perspectives: playability, enjoyability, usability and learnability. These perspectives derive from Caillois' (2001) game definitions, Csikszentmihalyi's (1990; 2005; 2006) conception of the flow experience and a practical outlook on usability in the playground context. In addition, the game is evaluated through the socio-cultural views of learning (Vygotsky, 1978, Mercer, 2002, Säljö, 2005, Wells & Claxton, 2002).

2 Research Context and Game Concept

The Playful Learning Environment (PLE) is a new type of learning environment in that it combines outdoor playground equipment and technological tools, thus formulating an innovative setting for playing and learning (Hyvönen et al. 2006; Kangas et al. 2006). Consequently, the goal of the PLE in the school setting is 1) to offer possibilities for children to learn curriculum-based topics by playing on the outdoor playground, 2) to provide more opportunities to use physical and bodily activities during the school day, and 3) to make it possible for children and teachers to create their own (curriculum-based) games and contents for the playground and its game applications via classroom computers. The pilot PLEs were realized in the city of Rovaniemi, Finland. The basic playground elements include solutions of identification technology (RFID, Radio Frequency Identification Device): the main computer ("iStation" Central Unit), identifiers (tags look like key rings), iPost info poles (on the playground), and game development tools. All users carry identification tags in order to interact with the iPost info poles and the iStation on the playground (see http://www.smartus.fi). The players get instructions and information on the basic game applications via the computer screen. This study focuses on the testing of a game concept designed *for one of the PLE playground devices*.

The Space Treasure game concept and theoretical game design model were designed by Suvi Latva (2005). The game concept was designed for the wave platform (Figure 1.), which consists of wobbling steps to walk on. The game provides *physical activity, mathematical reasoning and practice*, and *treasure hunting* in the imaginative *frame of a space theme.* Basic mathematical calculations, such as multiplication and division, are included in the game concept.

Figure 1. The play equipment "Wave platform" for the game concept

The play equipment for which the game was created represents space and includes various types of challenges and incidents. Two to four children can play the game at once. There are four starting planets, one in each corner of the play equipment. The player who finds the hidden space treasure and brings it back safely to a home planet is the winner. On the voyage the players must beware of bandits; behind any step a bandit may appear and seize the sought treasure. Also, the treasure holder may be threatened by the other players during the game. For example, the following incidents may be lurking under any step:

- Space treasure, which is meant to be found and taken safely to a home planet.
- Space bandits, who can steal the space treasure. In this case the treasure is hidden again under any step.
- Diplomatic immunity passport, which can be beneficial, for example, when space bandits attack or other players try to seize the space treasure. The passport can be used only once.

Before the game, the players choose the planets of the solar system that the corners represent. The player may start from any corner; in this example the player starts from corner no. three. From there, the player may move to another step as long as its number can be used to multiply or divide the number from which the player left. According to the multiplication option, when the player is first standing on step 3 and moves to step 2, he or she must move to step six (3 x 2 = 6). Under this step, one of the already mentioned "incidents" will then emerge. If step 6 contains, for example, a "space treasure", the player's task is to try to take the treasure safely to the home planet. If the holder of the treasure has diplomatic immunity no-one can steal the treasure – even if they stood on the same step. The winner of the game is the one who manages to take the treasure safely to the home planet.

3 Theoretical Background

3.1 Playful Learning in an Informal Setting

In recent years, with the rapid development of novel learning environments enabled by digital technologies and digital games, a number of new concepts and theories have been built up in the field of learning. However, there is no game-related research on technology-enhanced playgrounds or playground equipment. In our educational studies we have concluded to use *playfulness* (cf. Liebermann, 1977) as a conceptual tool for evaluating the PLE and its activities (Hyvönen et al., 2006; Hyvönen & Kangas, 2006). According to Egan (2005) playfulness in learning processes may help to think about the world in a way freed from the constraints releasing the mind to reflect back on the world. Sutton-Smith (2001) classifies play according to the ways in which *persons develop within play*. The highest level of development is represented by playful forms of play. These forms of play are typically demonstrated by the variety and complexity of *playful transformations* during the game. PLE in school context provides exciting circumstances for *playful learning* that is mainly seen as a means for children to learn according to the curriculum in an informal setting.

According to Säljö (2005), it is not necessary to question whether children are learning while playing: instead, we should ask what they learn in playing situations. We highlight the socio-cultural approach (Vygotsky, 1978; Wells & Claxton, 2002; Säljö, 2005), which emphasises various cultural tools when acting and learning. The PLE comprises cultural artefacts (outdoor playground equipment, technological tools, and computer software), social networks, and mediated activity when children play and learn together. Thus, playful learning in the PLE is grounded on physical, social, emotional, cognitive, and cultural aspects and goals.

When using the PLE or the Space Treasure game in a school setting, the purpose is to combine the topic, play, and learning activities into a single entity. This is possible by integrating the topic or classroom activities seamlessly with playground activities. We have concluded in our studies that playful *learning processes* (PLPs) should consist of three phases: (1) *orientation,* (2) *playing*, and (3) *elaboration* (Hyvönen et al., 2006; Hyvönen, [Submitted]; Kangas et al., 2006). This was also applied in this study: first, the rules and plot of the game were introduced to the children (orientation), then the children played the game (playing), and at the end the researchers asked the children to state their experiences and reveal their new ideas (elaboration).

In this study we examine the game concept from a transdisciplinary perspective and from the viewpoint of diverse disciplines and theories. Therefore, the theoretical background is also based on four distinctive perspectives that have been proven critical in the design of PLEs as technology-enhanced and game-based learning environments. The following concepts were included: *playability, enjoyability, usability* and *learnability.*

3.2 Playability

Roger Caillois' (2001) definitions of play apply well to the examination of the Space Treasure game in the PLE setting. He has divided games roughly into four groups according to the types of player experiences. In accordance with the term *playability*, as used in this study, a game should afford experiences in all of the following four groups: 1) *Agon*, denoting games in which the central aspect is competition, 2) *alea*, which denotes chance- and luck-based games, 3) *mimicry,* denoting games based on imitation and simulation, and 4) *ilnix*, which stands for vertigo- and physical achievement-based games. Caillois also differentiates games with respect to their rules: there are games of free play (paidia) and rule-based games (ludus). His game definitions fit well with a physical, activity-based playground equipped with game applications.

When Caillois' game definitions are examined from Csikszentmihalyi's (1990; 2005; 2006) perspective of optimal *flow-experience*, it can be concluded that games offer the possibility to attain more than the usual play experiences *in four* different ways. For instance, in games belonging to the agon group the participants must stretch their skills in meeting the challenges that arise from their opponent's skills. In this case the individuals attempt to be more than they are in reality. This can be perceived as a clear connection with Vygotsky's (1978) notion of the Zone of Proximal Development (ZPD). He has defined the ZPD as the distance between current levels of comprehension and levels that can be achieved in collaboration with other people or powerful artefacts. Although flow does not necessarily require social interaction, its attainment forces the individual to higher performance levels and thus leads to self growth.

3.3 Enjoyability

The psychological significance of the flow-experience is based on the fact that *it brings enjoyment to the individual.* In order for playing to bring enjoyment, motivation must arise in the players themselves (Csikszentmihalyi, 1990). The game should offer sufficient challenges because supporting the flow experience to lead to states of enjoyment educational games should stretch a player's mind to its limits in his effort to overcome worthwhile challenges (Kiili & Lainema, 2006). When a player's interest is directed toward a type of activity which he or she is not yet able to perform, it can spark the flow state and at the same time be a sign of the activation of the ZPD. According to Csikszentmihalyi (2005; 2006), it is not significant what the actual challenges of a situation are. Rather, the important challenges are the ones the individual is *aware* of and believes can be attained. Thus, the realization of the flow state necessitates a balance between skills and the task at hand. It is therefore unnecessary to seek out increasingly challenging tasks in order to motivate learning and development. However, play could be seen not only as a source of pleasure but also as a bonus: it reduces stress and enhances children's motivation to learn (Sutton-Smith, 2001).

3.4 Usability – Challenges in Playground Settings

Usability within the outdoor playground context is quite an unfamiliar theme in scientific research so far. Generally, the user interface can be seen as a link service or application between the child or teacher and the system (Lankoski et al., 2002). It can be a computer keyboard and a mouse or a new piece of playground control equipment built for a playground concept. The traditional user interfaces of digital games, such as the keyboard, mouse and 'joystick', have recently been complemented by so-called bodily user interfaces. In this study, *bodily user interfaces* are defined as broad-bodied, moving and controlling user interfaces (Kuivakari et al., 1999). The technological tools realized in the PLE are based on RFID readers, which send feedback to the "iStation" on the playground. Also in this case the feedback

channel is the iStations' computer screen. The existing RFID technology doesn't cover the play equipment designed for the Space Treasure game concept. Therefore, this paper presents *the testing results with a simple version of the game*
.
A feasible user interface for the playground should differ radically from traditional, joystick-type digital game user interfaces, because it should be able to serve specifically children's activeness and sport activities. From the start, the SmartUs team has considered different solutions, amongst others touch-, weight- and tensile-based user interfaces, which are easy to integrate into several types of devices. We have done this because e.g. jumping and climbing are very typical forms of activity in the playground environment. For example changing symbols, lights, sounds, letters, and numbers are possible choices for the playground equipment. Usability tests have played a significant role in our effort to improve the usability of the PLE. Consequently, the results of this study are important in this respect. It also describes the ideal usability settings for the game concept at a hypothetical level.

3.5 Learnability

We refer to the term *learnability* in two ways: *how easy it is to adapt to the system* and *the games* and *how it promotes learning*. According to Laakkonen and Isomäki (2005), learnability is divided into three dimensions that measure learnability and define its objectives and properties. In our case, measuring (time, errors and rating) is not important; instead, it is necessary to know whether the idea of the game is understood. Regarding the properties of learnability, intuitiveness and overall learnability, it is important to consider when the game concept should be tested and implemented. User experiences are salient in the adoption of a system (Laakkonen & Isomäki, 2005); it is important to know what meanings the system provides for users. How do they adopt *the plot and the rules* of the system (the game)? And how do they adopt *physical activity* as an essential function in the game? In line with Laakkonen and Isomäki (2005), we emphasize user *satisfaction* and evaluate it against modern learning theories.

4 Aims and Research Questions

The aim of our study was to investigate the use of the Playful Learning Environment (PLE) in curriculum-based education. More precisely, the objective was to examine the Space Treasure game concept by testing the game with schoolchildren on the wave platform, for which the game concept was designed. We also assessed the concept from the following perspectives: playability, enjoyability, usability and learnability. The research questions are:

1) How does the Space Treasure game concept meet the challenges of playability, enjoyability, usability and learnability?
2) How do the children experience playing the Space Treasure game?

5 Methods

The study builds on Design-based research (Barab & Squire, 2004; The *Design-Based Research* Collective, 2003). It focuses on the *designed innovation* (the game concept) and its use within a naturalistic school setting. According to the Design-Based Research Collective's (2003) arguments, design-based research in education affords the following: 1) exploring the possibilities of creating novel learning and teaching environments, 2) developing contextually-based theories of learning and instruction, 3) advancing and consolidating design knowledge, and 4) increasing our capacity of educational innovation.

In addition, design-based research goes beyond merely designing and testing a particular intervention that embodies specific theoretical claims about teaching and learning, and reflects a commitment to understand the relationship between theory, the designed artefact, and practise (The Design-Based Research collective, 2003). Consequently, the study intends to produce new design principles, theories, and practices for PLE contexts by revealing the children's experiences of the game and by evaluating the game concept. The initial design focused on developing a game concept and game design model for playground settings (Latva, 2005). This was followed by cycles of redesign, implementation, and proto tests by the cross-disciplinary SmartUs teamii. After that, the game application was implemented and tested at Kauko Primary School in Rovaniemi, Finland, and the first research data was gathered. The study was conducted as follows: Children (N = 18) from the fifth and sixth grades (aged 10 to 12) played the game in groups of three or four. Ten boys and eight girls participated in the study. Most of them played the game several times.

The rules and the plot were explained to the children before the game was started. In addition, the children had a possibility to observe other children's play and to adopt the rules of the game also in this way. Because technological appliances were not available, *the researchers simulated technology* by shouting for instance "space-treasure" or "space-bandit" when a child landed on a step where the treasure or bandit would hide according to the pre-drawn plot. The children were able to see only numbers (2 to 12), which we attached on the 25 steps. They could move into all directions by using the available numbers for *multiplying and dividing*, and they were asked to verbalize the mathematical operations they made and allowed to suggest further rules to the game. The edges of the wave platform simulated the "home planet" of each player and were the starting points of the game. The aim was to avoid bandits, find the treasure, and bring it to the home planet. The researchers tutored and advised the children during their play. The data collection was carried out in February 2006.

The data was collected by observing and videotaping all the game implementations and by interviewing the children briefly after playing. They were asked to describe their emotional experiences and thoughts regarding the challenges, learning, and plot. The interviews as well as the video material of the game processes were recorded and transcribed. The focus of the observations was on playability, usability, enjoyability, and learnability. The video material was analyzed through a content analysis that revealed two dimensions: one is related to the environment and the game, and the other to the children's skills that they practiced during playing.

6 Results: Experiences and Assessment of the Game Concept

In this chapter we consider the game concept and the results of the study through the socio-cultural framework and through four categories: 1) *playability,* 2) *enjoyability,* 3) *usability,* and 4) *learnability*. The categories are somewhat overlapping because the concepts relate strongly to one another.

6.1 Playability

Applying the Space Treasure game to the playing equipment involved all of the four game forms: *agon, alea, mimicry,* and *ilnix* (see Caillois, 2001). Of these, agon and alea were more dominant. **Agon** refers to competition and was manifest between the players; who would succeed in taking the treasure to a planet first. The study revealed that the children played, solved mathematical calculations, and made game strategies **by assisting and supporting each other**. Although the goal was to compete to find the treasure, they often seemed to collaborate to find it. In fact, the experiences of the game supported *the core idea of competition*. In other words, the word "compete" has its roots in the Latin words *con petire,* which mean "search together". Every player searches for the realization of their own potential, and this task is made easier if the players force each other to do their best. (Csikszentmihalyi, 2005; 2006.)

The following extract (1.) is a good example of the children's **collaboration** during the game. It was Matti's turn to make a calculation and move on the playground. Although one of the boys tried to trick Matti, the other children gave him advice. Moreover, although the calculations were quite easy for most of the children, creating an appropriate game strategy and making the right moves on the platform provided them enough challenges.

Extract 1. Noora, Kalle, Matti and Niko play the game
(It is Matti's turn to make a move.)

Noora:	Make it this way: two times three and jump there!
Kalle:	Wait a minute…
Niko:	Two times two is fourteen!
Noora:	Let me say,…jump to "two", and then, from here to "three"
Matti:	Wait! Two times three is…
The others:	Six!
Matti:	Six (jumps to the home planet)
Niko:	Right, Matti, two times three is six

Alea refers to *chance* and *luck* (Caillois, 2001). In this game chance and luck existed "beneath" the steps. The data shows that *alea* as a phenomenon seemed to improve the playability of the game: although treasure seeking was occasionally hard, it was the basic activity of the game. The children felt joy when they found the treasure and when they tried to prevent the others from finding it, or when they tried to avoid the space bandits. This made the game more exciting: You never knew where the treasure was and you never knew the intentions of the others. A clear strength of the game is that it is not founded on elaborate mathematical calculations – it is based on chance, as well. Thus, it provides low-achieving students an opportunity to practice their basic mathematical reasoning, and with the element of chance they can also be successful players.

Mimicry refers to *imitation* and *simulation.* In this study, it appeared in so far as the children put their souls into the plot and imagined themselves in space. The children were in an imaginary game world from time to time, although the testing procedure and the plot were very simplified compared to the original game concept. The observations and video analysis revealed that mimicry did not play a huge role in the children's activities during the game tests. For instance, the words the children created during the game built only on the key incidents: *the treasure, the bandit*, and *the home planet*. The space theme did not emerge in any other way. The children also wished for more props, such as lights and sounds, to the surroundings to experience more space-like feelings. According to Bodrova and Leong (2001), children need only minimal props for role-play. However, no props at all were provided in the test situation. Nothing but imagination was used to create space surroundings around the wave platform, and yet the children reported in the interviews that the plot was convenient and interesting.

Finally, *the motorically demanding wave platform* can be related to **ilnix**, because the steps float and encourage stepping on and moving around. Floating steps require body balance skills. Particularly from the perspective of motor coordination, this is one of the most important qualities of the game; therefore, a game based on the wave platform provides opportunities for physical development. It's generally argued that coarse motor skill development can be seen as a base for the development of fine motor skills, and also for children's broader social and cognitive development (e.g. Rintala et al., 2005). During the study the children moved and jumped about actively throughout the entire play session. It was also possible to enhance the movement of the play equipment by waving a pole in the middle.

6.2 Enjoyability

The study showed that the children experienced the play equipment as more pleasant and interesting after it had been added to the narrative game plot. When they played the game they often tried to keep up the game by creating game strategies and calculations in collaboration with each other. These findings suggest that they tried to maintain the enjoyability of the game. According to Csikszentmihalyi (2005; 2006), enjoyability is realized in the optimal *flow experience* and in situations where an activity *contains rules, necessitates the learning of skills, is goal orientated, offers feedback*, and gives *an opportunity to control* the situation. The central purpose of flow experiences is to bring about enjoyment and experiments of joy. The game application offered feedback at various levels: a) initiative feedback on the target step (adults' guiding reaction; shouting), b) researchers' tutoring during the game and c) peer control relating to the steps and calculations. The players were willing to play the game again and again, and to challenge each other to hunt the treasure. Extract 2 shows the players' **willingness to create a common strategy** in order to prevent other players from winning and to prolong the joy of playing.

Extract 2. Noora, Kalle, Matti and Niko play the game

Niko: Matti, step two times two; it makes four (ponders the route at the same time)
Matti: Two times two is four (steps on the play equipment)
Niko: You should have stepped there (points at step 4)
Noora: You can't change the route anymore.
Kalle: What number do you have there?
Noora: Two.
Niko: Two times two is four (proceeds on the steps)
Kalle: You need step two there!
Noora: We have to block all steps number four!
Kalle: Yes, we do! Then he can't go there. (means Matti who is almost the winner)

During the tests the children were allowed to make propositions concerning the rules. They also suggested and tested several new ideas. According to Csiksezentmihalyi (1990), the experience of enjoyment relates to action particularly when children themselves are allowed to give input when a game is being constructed.

6.3 Usability and Learnability

Because moving along the steps is the basic function of the play equipment, it supports a user interface placed inside the steps. In this case, the platform provides intuitive information about its use (cf. Laakkonen & Isomäki, 2005). In this study the researcher simulated the technology by shouting the name of the incident when a child stepped on a tile. The results of the study show that this simulation didn't disturb the children while playing the game. Instead, it functioned well as feedback in the test situations. The cardboard numbers on the steps are a possible numbering solution, and none of the children mentioned this "man-made" digital technology as a problem. Based on these results we can say that the human adaptation to technology provided an adequate task match with regard to user control and informative feedback (cf. Laakkonen & Isomäki, 2005). In addition, the children understood the plot and rules of the game easily and asked detailed questions about the rules. This indicates that the *children adopted the innovation without difficulty* and were able to understand the "meaning" of the activity. The findings are promising even though it was not possible to test a real-life application of the game concept.

6.4 Views of Learning

From the educational perspective the results led to a significant finding: the game offered *a meaningful way to practice basic arithmetic skills in an informal setting.* Therefore, the power of the game also lies in the opportunities it offers to practice multiplication and division. We had chosen small numbers for the game tests, which is why the calculations were not challenging enough for most of the children. This was the clearest impediment of the tested game version. The children reported "too easy calculations" although they had sometimes difficulties in forming the calculations the right way. Consequently, it was no surprise that the children suggested varied calculation methods (addition, subtraction, multiplication, and division) and higher numbers for the next version of the game. Problems emerged especially when the children used divisions; perhaps for this reason they avoided divisions when moving on the platform. It was difficult to think what the order was and to remember that the step on which the player was standing began the calculation. Nevertheless, they enjoyed playing the game and felt they learned while playing. They reported to have learned *motor skills, mathematical reasoning, and logical thinking* in constructing the game strategies.

Because neither the play equipment nor the game application itself checks the received results, it forces the players to collaborate when solving problems. This became evident during the games. Every player had the opportunity and was challenged to solve equations created by others and to choose between different routes. Enabling social control also gave each player the possibility to speak out loud about the constructed equations. Sharing one another's mathematical reasoning through verbalized thinking appears to develop children's *metacognitive skills* (Flavell, 1976), i.e. the skills to control, monitor, and assess one's own activities. In addition, collaborative problem solving offers the possibility to acknowledge one's own and other people's decision-making and mathematical processes. These kinds of learning activities also provide potential for socially *mediated metacognition* (Goos et al., 2002). The next extract (3.) shows how **the players control, reflect on, and support one another's calculations.** An adult also participated in the discussion.

Extract 3. Matti, Noora and an adult
Noora: The treasure may be here!
Matti: (planning his own move) Two divided by six is three.
Adult: Two divided by six is three. (repeating)
Kalle: No, it's not! Can't be!
Matti: (thinking)
Adult: The other way around. Look, if you divide two by six…
Matti: Three divided by two is three (losing his thought)
Noora: No! (shows a route to Matti)
Matti: (finally finds the appropriate route, 6:2=3)

From the socio-cultural viewpoint, this kind of interaction during a game affords children to use language as a tool for thinking. It is argued that shared activity gives rise to *intermental understanding* and then leads to individual *(intramental)* knowledge and skill (Vygotsky, 1978; Mercer, 2002). Interaction within children's ZPD involves exposing them to more complex mental and physical activity than they can master on their own. Intramental knowledge in the game does not necessarily need to relate to mathematical operations only. Rather, it should relate to the plot of the game, the rules, the movements, the interaction skills, etc. From the perspective of learning, the strength of the game can be seen especially in its digital future versions: the game can accommodate students of different ages and skills. Moving from multiplication and division to more complex tasks adds to the challenge of the game and also enables learning processes in which the players can take active and reflective roles and thus develop their own understanding (cf. Wells, 2002).

7 Conclusions and Implications

In this article we have described the Space Treasure game concept as a part of the Playful Learning Environment. The goal of our study was to find ways to increase physical activity in the form of games in the school context. The study demonstrates that the outdoor PLE can be used successfully for that purpose. The study shows that outdoor game as a part of the PLE can be well applied to curriculum-based education employing the phases of orientation, playing, and elaboration (Hyvönen et al., 2006; Kangas et al., 2006; Hyvönen, accepted). The major outcomes and implications of the testing are illustrated in figure 1.

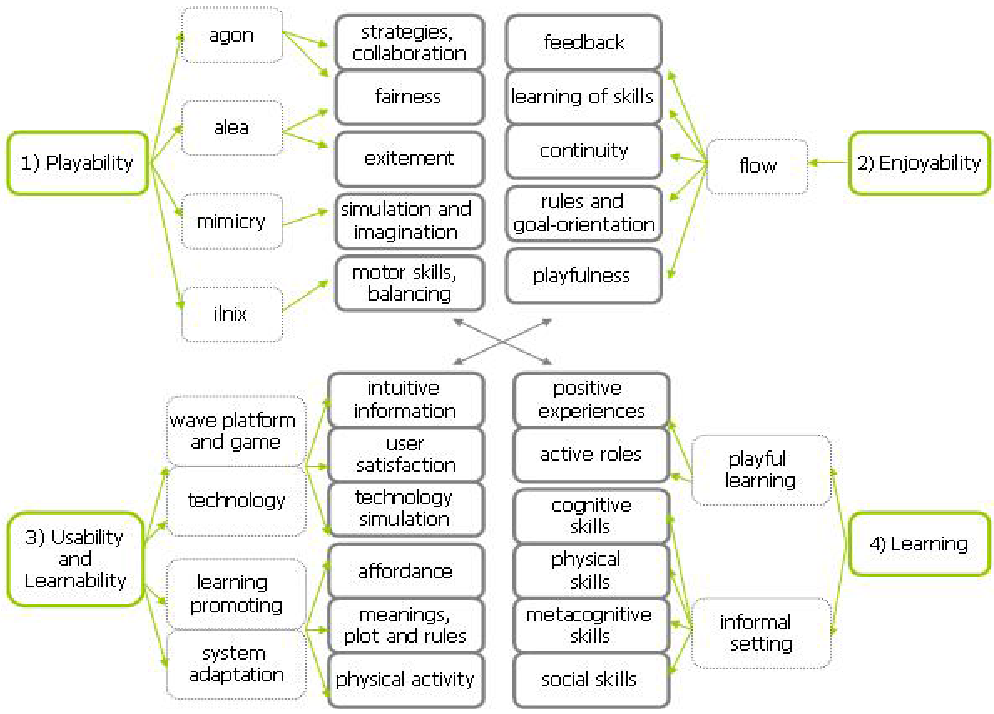

Figure 1. The outcomes and implications

(1) Playability is assessed from the viewpoints of Callois' (2001) definitions *agon, alea, mimicry,* and *ilnix* and the correlations found through testing. The play strategies, which were usually made collaboratively, correlate with *agon*. The children's aim was not primarily to win the game, but to carry on the play as long as possible; this manifests the features of mature play (Bodrova & Leong, 2003). Although the idea was to win the game by finding the treasure and by bringing it to a home planet, the process itself seemed to be more important: to play *collaboratively* and to prolong the *excitement* provided by playing. Hence, excitement refers to *alea*. In addition, the game was not based on mathematical operations only; it was based on chance as well. Thus, the game treats *fairly* players of different developmental levels.

The context of the game related to *mimicry.* It was a *simulation* of the space environment created through children's imagination. However, mimicry and fantasy could have been supported more. One option is to use appropriate technological solutions that provide a suitable atmosphere for imaginary game worlds and enhance the audiovisual properties of playing processes. One interesting option is to use StoryMat-type technology that "listens" to children (Cassell & Ryokai, 2001). During the game, children would make imaginary sounds relating to space and the Solar System, and tell brief narratives about the ongoing space adventure. In doing so the meaning of the moves from one step to another would be connected to the plot of the story.

During the tests the children used and practiced their *balancing* and *motor skills* that recount to *ilnix*. Body control and motor development relates closely to the common concern that there are not enough physical activities available to children during school days and leisure time. There is a great deal of games available, but only few of them are designed for outdoor use and provide physical activity. Alongside with the PLE and Space Treasure, the Camelot outdoor game (Verhaegh, et al., 2006) and Playware – intelligent and tangible play environment (Lund & Carsten, 2005) are examples of games that encourage children to physical activity.

(2) Enjoyability is examined in the light of Csikszentmihalyi's (1990) flow experience. Although the flow experience was not measured in detail and not necessarily even present in the testing, it was apparent that the children felt some

sort of enjoyment. The *learning of new skills, goal-orientation, continuity, feedback, rules, and a possibility to create strategies* provided satisfaction and made the playing challenging enough. Hence, in spite of the easy numbering on the steps, the children found it challenging to create game strategies and to move around by dividing, for instance. The game caused enjoyment that is also typically related to *playfulness:* It generated clear goals, close attention, loss of self-consciousness, intrinsic motivation, and the belief that an experience is worthwhile for its own sake (Csikszentmihalyi, 1994; 2006). It is also noteworthy that bad playability could be seen decreasing the likelihood of the flow experience because the player has to sacrifice attention and other cognitive resources to the inappropriate activity (Kiili & Lainema, 2006). From this viewpoint, the Space Treasure game tests were promising because the children adopted the game quickly and focused on the calculations and hunting the space treasure.

(3) Usability was considered from two angles: we studied the usability of the wave platform and the game, and the usability of the technology. Learnability had also two dimensions: how the system is adopted and how it promotes learning. The Space Treasure game implemented on the wave platform was promising. The platform and the game could be used and played rather *intuitively. The tasks, the content, and the context matched* pretty well. The technology *was merely a simulation* of one potential technology. The simulation, however, succeeded sufficiently for test purposes. Enhancing the Space Treasure game with digital technology, along the lines of Camelot technology (Verhaegh et al., 2006), could yield opportunities to provide feedback and to make some of the game activities more challenging. On the grounds of this study, technology is an actual *affordance* for supporting learning, and quality of play. However, we need to be cautious when speaking of the affordances of new technologies and assuming that technology will automatically afford particular learning outcomes (John & Sutherland, 2005). Education is always a unique combination of technological, social, and educational contexts and affordances (Kirschner, et al. 2004).

(4) Playing and informal learning situations provided positive experiences for the children. They tutored each other and felt that they benefited from playing in the *physical* and *cognitive* areas. Test playing seemed to promote the children's social skills as they collaboratively negotiated the plot and the rules. Moreover, it promoted their *metacognitive skills* as well. The game experiences were consistent with the socio-cultural view of learning (e.g. Vygotsky, 1978; Wells & Claxton, 2002; Säljö, 2005): learning is a phenomenon whereby people share their experiences of their environment through various forms of communication. In all cases interaction between the players seemed to encourage collaboration and enhance the children's level of engagement (cf. Price, et al. 2003). Thus, peer interaction and collaborative activity proved to be salient in play (cf. Parr & Townsend, 2002) although the Space Treasure game had been designed to be a game in which only one player wins.

8 Discussion

Novel play and learning environments and computer-based game technologies seek to offer physically challenging and immersive play experiences (Höysniemi et al., 2005) and to create powerful and engaging learning experiences (Facerw et al., 2004). The findings of this study are interesting and provide opportunities to extend this field of research. The purpose of the PLE is to offer children more play, physical activities, and novel learning experiences in curriculum-based learning settings. The Space Treasure game can enhance learning both in formal and in informal contexts. This, however, requires proficient technological solutions modified for the wave platform and user-friendly applications with which educators and children can create games for their own purposes. In the Space Treasure game, the values on the steps should be chosen, mixed, and even combined with other numbers according to user preference. Using the classroom computer, it should also be possible to organize different adaptations of the game, to follow the playing and counting, and to evaluate the processes of play together with the children. This requires technical solutions that make the processes visible. Game creation via classroom computers is already possible in other applications of the PLE game technology, and this provides us more opportunities to study playful learning processes (PLPs) and playful learning, and to build theories on it. It is evident that the use of innovative technologies should complement children's natural play, which makes the PLE and similar innovations (e.g. Playware and Camelot) well-grounded solutions for learning by playing.

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Cooperation with the Smartus team [http://www.smartus.fi]
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Learning by Teaching: A Case Study on Explorative Behaviour in an Educational Game

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Learning by teaching is a widely studied method and it seems to be the ideal starting point for an educational game. Despite this, there is only few learning by teaching –based games. The aim of this study is to find out the strengths of the learning by teaching -types of games. This study is a design experiment with a pre- and post test. The pupils participated in this study (n=24) were 6 years old pre-school pupils. During the game play there were researchers and kindergarten teachers present to help the pupils if needed. Game play lasted approximately two hours. Pupils were observed by logging all human computer interactions with computer and by traditional observation. The main result is that a great number of pupils gained from learning by teaching –type of game, but there are also threats: In certain circumstances a pupils might get confused that decreases learning outcome.

Keywords: educational games, explorative learning, learning by teaching, game design

1 Introduction

Cognitive tools are utilized to support cognitive processes of the learner. The cognitive tool should affect reflection in which the learner is forced to evaluate his own conceptual structures and assimilate a new issue to existing conceptual structures (Jonassen 1994; Jonassen & al. 1997; Pea 1994). Nonetheless, if we do not consider quizzes or interactive tasks as games there has been only few learning by teaching –types of games. One of the best-known learning by teaching approaches is Betty's Brain (Biswas & al. 2005). In learning games, traditionally, the machine is the teacher, tutor or controller of the learning process.

Educational games, too often, tries to remain formal way of learning with strict goals. Maybe, the role of the pupil is the reason why educational games has been most useful for the pupils with relatively low skills in the subject that game is focused on (e.g. Sinko & Lehtinen 1999; Mayer 2001; Ketamo 2003; Virvou et al. 2005). When allowing a learner to use their previous knowledge and let them see how the knowledge fits into the game, the game remains the idea of 'Learning by Doing' (e.g. Dewey 1938). In this kind of approach the game would no longer be a teacher: the game only ensures that learner has got the skills and knowledge, required to pass the game.

Learning by doing as a backbone of an educational game may also increase the motivation towards learning: The positive relationship between cognitive and motivational themes in mathematics learning has been widely studied (e.g. Rao, Moely & Sasch 2000; Lapointe, Legault & Batiste 2005; Mason & Scrivani 2004). There is no absolute understanding that increased motivation automatically increases the learning outcome for all pupils. Therefore the learning outcome of educational games should not be discussed only with terms of motivation.

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2 Aims, objectives and methods

The research tasks are 1) to find out the efficiency of learning by teaching -types of games and 2) to find out explanations for this efficiency.

This study is a design experiment with a pre- and post test. The aim of pre- and post test was to estimate the learning outcome. The data was collected during years 2005-2006. All pupils participated in this research (n=24) were 6 years old pre-school pupils.

Pupils were observed 1) by logging all human computer interactions (HCI) with computer and 2) by researcher (manual notes). In every game play there were enough researchers and kindergarten teachers present to help the pupils and discuss about gaming etc. Researchers and teachers did not play the game.

The key variable in this study is learning outcome. Learning outcome is based on achievements in pre- and post test. Measuring instrument was the same as used in author's previous studies (e.g. Ketamo 2003). Most variables are only instruments for analysis and the values or results are not directly transferable outside this context.

3 Implementation of the game

The idea of the geometry game (Ketamo & Suominen 2005) is to put a learner (later player) into a role of a teacher. The pedagogical background of the game is in Learning by Doing (Dewey 1938), Learning by Teaching (Gartner 1971) and Learning by Programming (Papert 1999).

In the beginning of the game the player get her own virtual pet, an octopus, which wants to learn geometry. The octopus do not know anything, its mind is an empty set of concepts and relations. The octopus learns inductively: Each teaching phase is recorded into a concept network, for example concept A belongs into same group as concept B or concept A do not belong into the same group as concept B. In the game play these relations were used logically: In correctly answered question the octopus got two 'do not belong' relations and one 'belong' relation. In case of false answered question the octopus got one 'do not belong' relation. During the game play the conceptual structure in octopus's AI develops. When octopus had got a certain size of concept network, it could start to conclude.

Interesting part of teaching is the possibility to teach wrong. Sometimes the wrong teaching was not due to low skills: especially at the beginning of the game some pupils tried to teach colours instead to shapes. This tells us that such player have not listened the instructions. The instructions, originally spoken in Finnish by octopus, were following:

"As you may know, we octopuses love pirate's treasures, but there are not so many treasures left in the bottom of the sea. Nowadays we can get the treasures participating to the quiz called the Treasure of Caribbean pirate. The prize in the quiz has been found from the old Spanish pirate ships. In the quiz, two octopus compete which one recognizes more geometric shapes, such as triangles, rectangles, pentagons or ovals. The questions are answered by selecting which one shape does not belong into group.

I need your help now! I need to learn geometry for the quiz. Could you construct questions in the classroom? These questions should be 'which one does not belong into the group' types of questions. For example a question that include two triangles and one pentagon. When your question is ready, you can ask it by clicking the ask –button. Even if I do not know the answer I'll guess anyway. And after I have answered, you can tell me if my answer was correct. If my answer was correct, click the green 'correct' –button. If my answer was false, click the red 'false' –button. If you recognize that your question was impossible, you can cancel the question by clicking the yellow 'cancel' –button.

If you teach me well, I could become a master of the Treasure of Caribbean pirate quiz."

Implementation in this test instrument was designed to support reflective thinking. Usability issues were taken into account when there were no risks to decrease reflective thinking. There was an icon, brains (figure 1 and 2), in the game that describes the quality of learning. If the quality increases the brains increase, and if quality of learning decreases the size of the brains decrease. Wrong teaching could be corrected by teaching the correct structure enough times.

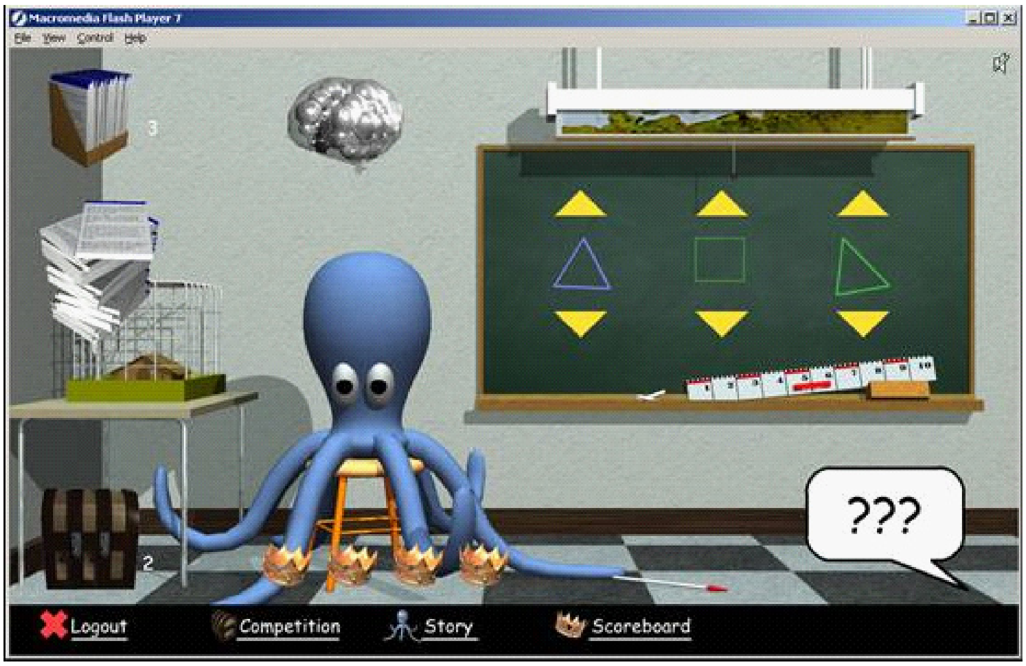

Figure 1. Question construction tools in the Geometry game.

In figure 1 the player has constructed a question which consists of two triangles and one pentagon. When the question is ready, player asks it by clicking the ask –button (button with three question marks). The octopus answers according to its previous knowledge. The octopus answers anyway, even if it does not know the answer or if the question is impossible, it will guess the answer.

In figure 2 the octopus has given its answer by pointing out the shape he thinks that do not belong into the group. The player should judge the answer: if the answer is correct, player should click the green 'correct' –button. If the answer was false, player should click the red 'false' –button. If the player notices that she had done an impossible question, the question can be cancelled by clicking the yellow 'cancel' –button.

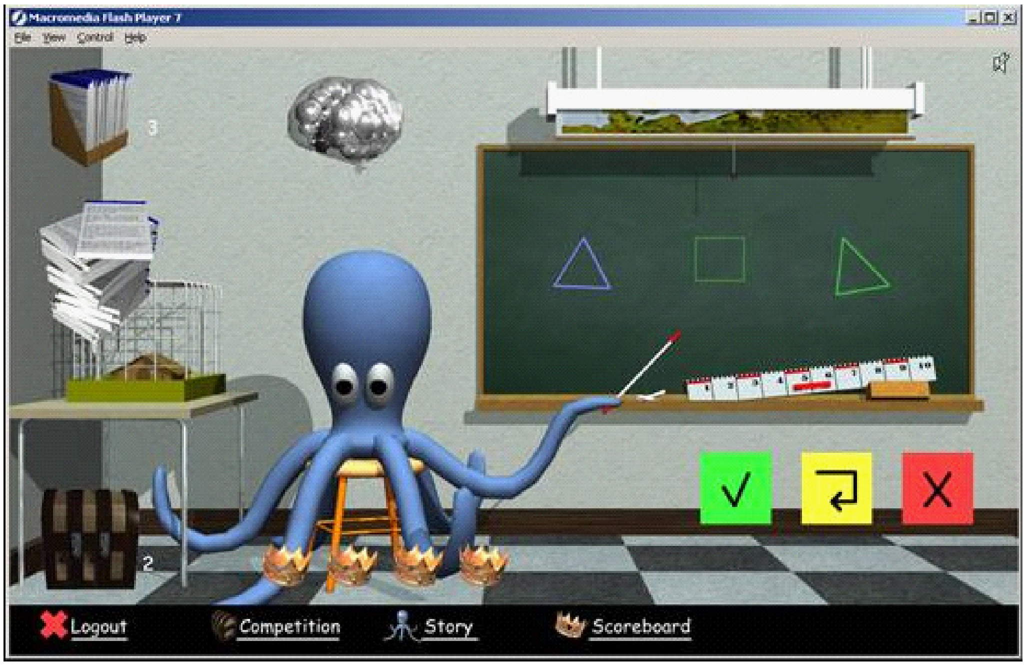

Figure 2. Answer evaluation tools in the Geometry game.

The classroom supports learning in two ways: At first, constructing a task requires knowledge about the subject. If there is not enough knowledge, players were encouraged to discuss about the problem with their friends. During this process the player had to apply her knowledge and/or increase her knowledge.

Secondly, judging the answers requires specific knowledge about the question. Basically a player can construct the question with smaller knowledge than answering requires. Now when the player should also judge the answer, the game requires also detailed knowledge about subject combined with applied knowledge.

The teaching itself was motivating, mostly girls enjoys teaching octopus. Some of the pupils expect something else than just teaching. Therefore there was a competition area, the quiz called the Treasure of Caribbean pirate, in the game. The game AI in the competition uses the same concept networks that have been taught in the classroom. In the competition a player can challenge her friend's octopus to play against her. Because all concept networks were stored in game server, a player could challenge opponents even if they were not online.

The competition (figure 3) was based on similar rules than teaching: the octopus should select which one of the shapes does not belong into the group. Both octopuses answer the same questions at the same time according to their taught knowledge. Question construction and judging was done by game server. The player's role was only to observe and analyze the performance. Of course, many players encouraged their virtual pets in the competition by whispering to octopus comments like "hey, it's the one on the middle". Also this kind of encouragement was supporting learning: when a player tries to advice the octopus she had to solve the question at the same time.

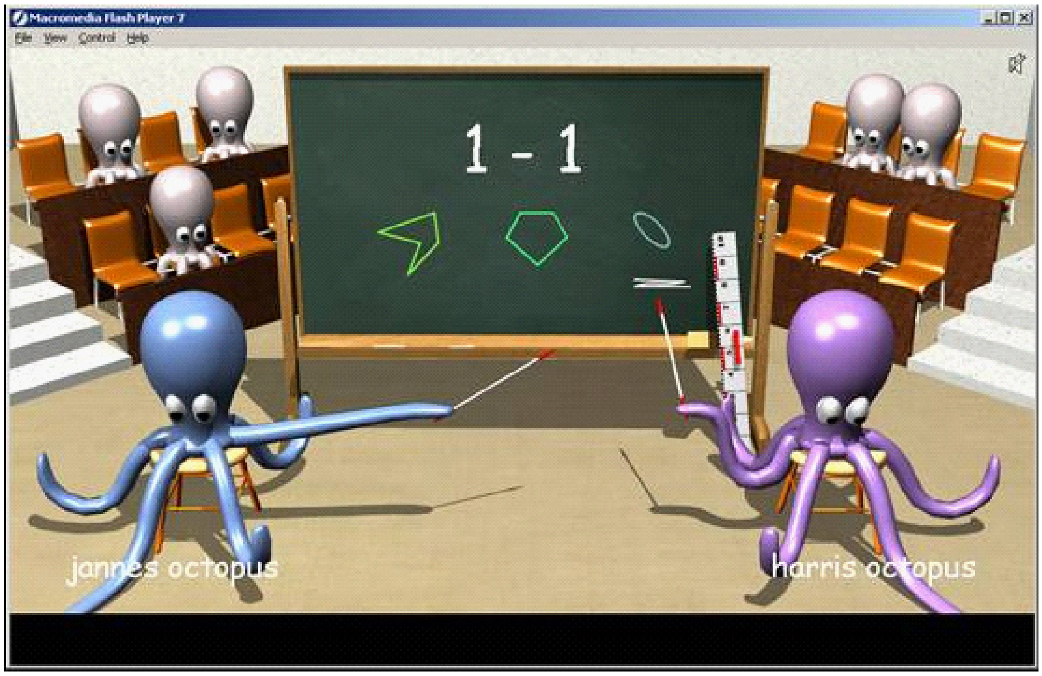

Figure 3. Competition in the Geometry game.

Competition was the reason to teach for most of the players. Especially boys wanted to compete. Most of the pupils understood the importance of teaching after they had lost few competitions. In fact they felt very motivated to check how well the octopus had been trained and then came back to classroom to teach more. Some of the pupils got even further: they went to competition only to check what weakness their octopus had. This kind of use of the competition shows that such player has relatively good meta skills.

5 Results

Almost all of the players enjoyed the game where they could take on a teacher's role. The children enjoyed the different themes in the game world. Most boys enjoyed competing and they got the reward from winning or seeing their position rise in the score table. Girls also mentioned that they liked to compete, but they also mentioned that teaching the pet is itself rewarding. Naturally the boys were teaching their virtual pets, but they did it in order to win competitions.

For the qualitative analysis of the games, the pupils are divided into four groups, according to the relative learning outcome. The groups are formed according to relative learning outcome and named by descriptive concepts as follows:

1) Successors: Those who have got a significant improvement during the game play (more than 50% better score in post test than in pre test).
2) Gainers: Those who have got improvement during the game play (10-50% better score).
3) Neutrals: Group consists of those who have got less than 10% improvement, but more than - 10%.
4) Non-gamers: Those who have got 10-25% weaker result in post test than in pre test. No one got more than 25% weaker result from the post test than from the pre test.

The average learning effect of the pre and post questionnaire is approximately 7.6% (Ketamo 2003) that also explains the negative outcomes in groups 3 (neutrals) and 4 (non-gamers). As in the pervious studies, those pupils who had little knowledge on geometry gained most from both of games. On the other hand, those who had good knowledge about basic geometric shapes did not get anything new from the games. So basically this was not a surprise.

The teaching phase and other human-computer interactions were recorded during the game play. These teaching profiles were qualitatively analyzed inside and between the defined four groups. The teaching profiles gave an interesting point of view into game play and especially in gaming strategies. The teaching profiles also explained some success and loss factors that would not be found from statistical analyses.

The successors group differs from other groups in their gaming behaviour: They tested different combinations, made mistakes and then corrected these mistakes. Those who have benefited most from the game have also had several 'observed problem – reformulated strategy – corrected problem' -patterns than others. The behaviour more resembles 'Learning by Doing' (Dewey 1938) than professional teaching. This gives also evidence to arguments that Learning by Teaching is a parallel method to Learning by Doing.

Also the non-gamers have remarkably different teaching profile than others. Their profile consist several weakness, for example wrong connections or only 'not the same kind' –relations. These are due to wrong gaming strategy or due to misunderstanding the goals of the game.

There was also some common confusion within all groups while playing the game. Ten pupils out of 24 (~40%), from all skill groups started to teach colours instead of shapes. This was mostly because they did not listen to the instructions. Some of those pupils correct their teaching strategy themselves some need guidance from researcher or kindergarten teacher. Interesting is, that 4 of those represents successors group. This indicates that wrong gaming strategy does not predict poor learning outcome, if the strategy is corrected. This makes the role of parents or teachers important when using games in educational purposes.

6 Conclusions

The most important feature of the teachable geometry game is the freedom of teaching: A pupil can freely teach whatever he wants and the game-engine itself do not restrict the process. In the best case, the game play remains explorative behaviour with trial and error phases combined to requirement of reflective thinking, in other terms learning by doing.

In this study, only the learning outcome is measured. Outcomes, such as strategic thinking, were not measured. Theoretically we can assume that in the game that requires complex actions, the strategic thinking will be also developed.

There were one major difference between the previous studies and this study: In the pervious studies there was not found clear negative learning effect. The game was not suitable for all pupils and some relatively good pupils got confused during the game play that reflects to their post test score. This leads us to conclusion that games are not good for all pupils. Even if the pupils like the game, there might sill be many better styles to tech an individual pupil. In this studied game even 40% of pupils did not benefit gaming.

The role of the teacher is important when using games in classroom. Teacher should guide and advices pupils during the game play. Without guiding, there is a great risk to learn wrong information while playing educational games.

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Mobile Technologies in Teaching and Learning

Reflective Learning and Facilitating Reflection with Authentic Learning Tools

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Reflective learning has been recognized as means for closing the gap between theory and practice. The aim of this study is to investigate authentic information gathering and knowledge acquisition as forms of reflective activities in personal portfolio development. During the academic year of 2006-2007, 14 prospective history teachers at University of Tampere, Finland, are developing a personal digital portfolio. The ProBlogger mobile blogging prototype tool is used to facilitate the opportunities to record, store and share their training experience in a personal weblog on-line environment. The content accumulated in the personal on-line weblogs is the material to be processed into a product portfolio - a document to be handed to the supervising teachers for final evaluation. The students have reported the use of weblogs as meaningful, although the link between the process and product portfolios was unclear to them. The students regarded commenting each others experiences in weblogs very useful. However, both the mobile blogging technology and the ways in which it can be used as a tool for learning still need to develop. To the students mobile blogging seems to be interesting, but they are still uncertain how to best use it. The mobile tool needs to be more flexible to give room for personal preferences in blogging, e.g. it should enable the storing weblog entries privately on-line.

Keywords: reflective learning, mobile learning, eportfolios, design research

1 Introduction

There is evidence to support the potential of portfolios as tools for enhancing learning and development (Tillema & Smith 2000) despite reports of a growing call to reconsider the value of portfolios in reflective practice: there seems to be need to define what the reflective activities undertaken in portfolio development process should be (Orland-Barak 2005). The study described in this paper provides a more specific understanding of the characteristics of authentic information gathering and knowledge acquisition as forms of reflective activities in personal portfolio development.

Reflective learning has been recognized as a means for closing the gap between theory and practice in education - that is, the gap between documented information and personal experience. In experiential learning, immediate personal experience is the focal point for learning (Kolb 1984). Experience alone is not, however, a sufficient condition for learning. Experiences also need to be processed consciously by reflecting on them. It becomes essential to support this reflection on experience after an event by providing a means to record, store and share this authentic information for later reflection.

This paper outlines a research project on authentic information discovery and use in learning tasks and how it has arrived to the defined research questions. This project investigates the relationship between Web searching, information

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literacy and learning and to clarify the interplay of information literacy and learning in the Web-dominated and mobile information environment. In a mobile information environment, contextual information discovery and use – observation recording, information searching and reporting – becomes possible. The aim of the study is to help construct learning environment for the authentic assessment and guidance purposes in subject teacher education.

2 Reflective Learning

Reflection plays an important role in the process of creating new knowledge and understanding through the transformation of experience by providing a bridge between practical experiences and theoretical knowledge in learning situations. In the learning process in education, work or practical situations the reflectivity, the reflective way of action and reflective relation to own professional development is essential (see for example Schön 1983; 1987; Brookfield 1990). Carl Bereiter and Marlene Scardamalia (1993) write about a self-regulative knowledge foundation when they emphasise the meaning of advanced reflective self-awareness in the professional growth process. Reflectivity creates a reciprocal relationship between experience and understanding and experiences and conceptualising. Reflective learning is a core component of learning in many experiential and professional learning theories (Kolb 1984; Schön 1983; 1987; Brookfield 1990; Bereiter & Scardamalia 1993; Cranton 1996).

Reflective learning can be defined as a concept which describes how actively the learner regulates his/her own learning and how critically the learner examines his/her own learning process, his/her knowledge, and his/her experiences in the different learning situations (cf. Korhonen 2003). In the background of these processes there are for example learner's earlier learning history, conceptions on self as a learner, expectations of the studying environment, emotions, intentions and ability to design learning and to set goals intentionally (Bereiter & Scardamalia 1993; Martinez 1999). In learning situations the personal orientation of the learner seems to be connected with the tension that is created between the learner's intentional action and the challenges and expectations appointed by studying environment. When reflecting, the learner grinds the theory with the help of the practice and understands the practice with the help of the theory. Reflective learning is at the same time a process and a skill for the action which becomes personal implicit theory in the future. The implicit theories of the expert (theory-in-action) develop in the dynamic interaction of knowledge, experiences, worldview and practical models shared with others (Schön 1983; Korhonen & Koivisto 2007).

When observing reflective action, different forms of the reflection and knowing can be identified. In Schön´s (1983;1987) empiric observations, three basic types of reflection and knowing came forth: the knowing-in-action, the reflection-in-action or the reflection-on-action. The knowing-in-action is expert's intuitive action, in other words so-called tacit knowledge without actual reflection. The reflection-in-action signifies that in the skilful practice the reflection is possible to perform intuitively as a part of the action. The knowing is as if intuitively knowing while operating. Reflection and the knowing are an unconscious process and a skilful actor cannot necessarily describe the character of the reflection or where his/her action is based. When an actor consciously stops to examine the action and experiences, reflection takes place after the practice in a reflection-on-action type form (Schön 1983; 1987). The reflection can be also be a reflection-for-action type process which precedes action (see Cowan 1998) and in which more advanced and more justified ways to function in new practical situations are built on.

The role that theoretical and conceptual knowledge have in the reflection process described does not become obvious by examining only the practical situations. Many researchers (for example, Kolb 1984; Simons 1999; Väisänen & Silkelä 2000) have described learning and development as a conceptual change which takes place in the students' beliefs with both the experiences and development of the theoretical knowledge which frames the action. For example, Simons (1999) analyses human knowing to three different internal forms of memory representations (episodic, conceptual and practical representation) which describe the different types of the knowing. The development process is a result of the interaction between all of these representations. In the development process both, theoretical and practical knowledge and reflective self-regulatory knowledge (Bereiter & Scardamalia 1993) are needed. However, it is worth noting that all learners are not necessarily reflective in their learning but are more externally regulated and operate according to the conditions of the studying situations - or they can have difficulties in the regulation of their own learning. (Korhonen 2003.)

3 Constructing Digital Portfolio with Authentic Learning Tools

As an initial part of this research, a questionnaire study was conducted to inspect the connections between learners´ cognitions and learning experiences in mobile technology supported learning activities. The study suggested that mobile devices show promise with regard to authentic information gathering (Syvänen 2006). The respondents consisted of 11 and 12-year-old students (n = 143) from three Finnish comprehensive schools, using a handheld computer, laptop, desktop computer and PDA. The findings of this study were that one characteristic of mobile technology supported learning is searching for information more freely from different contexts both in physical and virtual environments, and constructing knowledge by using this information. These kinds of learning activities could lead to development of flexible information literacy.

A few years ago when the methods for mobile technology supported learning were under discussion, one proposed strength of the activity was supporting learning taking place after the actual learning situations. It was suggested that one could address this as “ad hoc mobile learning” (Tirri 2003). This can also be taken as a form of accidental information discovery, a phenomenon pointed out earlier by Erdelez (1997). Therefore, the mobile tools should have a role in facilitating the opportunities to record the experience for later reflection.

Writing (blogging) on-line journals (weblogs) has has expanded beyond journaling. Weblogs have been considered to be a new hybrid of web pages and web forums in which the use of different media elements (text, pictures, animations, video clips) is combined with the dialogical nature of web forums (Wijnia 2005). Blended learning approaches combine various online instructional modes with zones for face-to-face interaction. A considerable portion of the ‘blending’ involved in blogging is student-directed, with students determining how much to incorporate insights from face-to-face discussions, Internet materials, and other sources (Oravec 2003).

Mobile blogging involves using mobile devices for sending picture and text entries to on-line weblog environment and has been proposed as a good solution in supporting the informal, unstructured contexts that often occur in a mobile setting, where a more profound understanding of the things learnt comes after the event and not during it (Beale 2005). In this study, reflection is studied as occurring after the experience (reflection-on-action) (Schön 1987). In a nutshell, the aim of mobile blogging here is to support this reflection upon experience.

There is a distinction between portfolios that support and reflect the reflective learning and portfolios that are presentations of acquired qualifications –Curriculum Vitaes. Recently, teaching portfolio developers have focused more on finding the qualities of reflection associated with portfolio use, rather than simply stating the personal portfolio development promoting greater reflection (e.g. Dysthe & Engelsen, 2004; Orland-Barak, 2005). Dysthe and Engelsen (2004) have as portfolio developers sought to promote digital portfolio use as tools in the learning process in addition to using the for documentation: building reflection, self-assessment and feedback into portfolio assignments and processes in a way that this material becomes part of what is documented. Also to support this aim distinctions between “process portfolio” and “product portfolios” are sought (Orland-Barak, 2005). Barrett and Carney (2005) have discussed the two disparate approaches in digital portfolio development; whether the emphasis in the personal portfolio development should be on the process or on the product. This is further reflected in whether or not the portfolio is a tool for assessment of learning or assessment for learning (see Table 1). Assessment of learning refers to use of portfolios for formative assessment with a product emphasis, while the assessment for learning refers to the use of portfolios as reflective tools with a process emphasis.

Table 1. Comparison of digital portfolios used as assessment of learning with those that support assessment for learning (Barrett & Carney 2005).

Portfolios used for the Assessment of Learning	**Portfolios that support Assessment for Learning**
Purpose of portfolio prescribed by institution	Purpose of portfolio agreed upon with learner
Artifacts mandated by institution to determine outcomes of instruction	Artifacts selected by learner to tell the story of their learning
Portfolio usually developed at the end of a class, term or program - time limited	Portfolio maintained on an ongoing basis throughout the class, term or program - time flexible
Portfolio and/or artifacts usually "scored" based on a rubric and quantitative data is collected for external audiences	Portfolio and artifacts reviewed with learner and used to provide feedback to improve learning
Portfolio is usually structured around a set of outcomes, goals or standards	Portfolio organisation is determined by learner or negotiated with mentor/advisor/teacher
Sometimes used to make high stakes decisions	Rarely used for high stakes decisions
Summative - what has been learned to date? (Past to present)	Formative - what are the learning needs in the future? (Present to future)
Requires Extrinsic motivation	Fosters Intrinsic motivation - engages the learner
Audience: external - little choice	Audience: learner, family, friends - learner can choose

ProBlogger 1.0, a mobile blogging prototype tool, was designed to enable reflective process portfolio development by enabling direct publishing of recorded experiences (text and photos) in a personal on-line Word Press weblog. As such, these learning tools provide possibilities for reflection on authentic learning events. These tools were taken to use by providing a rationale to the students similar to the Barrett and Carney (2005) definition of portfolios that support assessment for learning. This was done to underline their use as process portfolio development tools –to gather material that could be used later in producing the product portfolio. Earlier work on theoretical design frameworks have suggested four ways that technology can provide powerful scaffolding for reflection: process displays, process prompts, process models and a forum for reflective social discourse (Lin, Hmelo, Kinzer & Secules 1999). Presently these tools facilitate scaffolding for reflection by providing process displays (documenting one´s experiences helps to assess progress) and a forum for reflective social discourse (entries can be viewed and commented). ProBlogger for Nokia Communicator S80 mobile devices was developed in collaboration with School of Computer Science, University of Birmingham to support authentic information gathering (see figure 1). The ProBlogger can be used with a wireless data network connection, including in the University of Tampere Wireless Local Area Network (WLAN).

Figure 1. ProBlogger mobile blogging prototype and Word Press weblog (1 = ProBlogger: manage blog entries view, 2 = ProBlogger: edit blog entry view and 3 = Weblog: published blog entries view)

The on-line personal weblog environment serves as a place to store and share teacher training related experiences for reflection. Giving the students an opportunity to view and comment on each others entries supports their personal reflective learning process - the process side of portfolio development. From all this material accumulated in the personal weblog environments the students can draw material for their product portfolio: a document to be handed to the supervising teacher for evaluation and end-discussion (see figure 2 below).

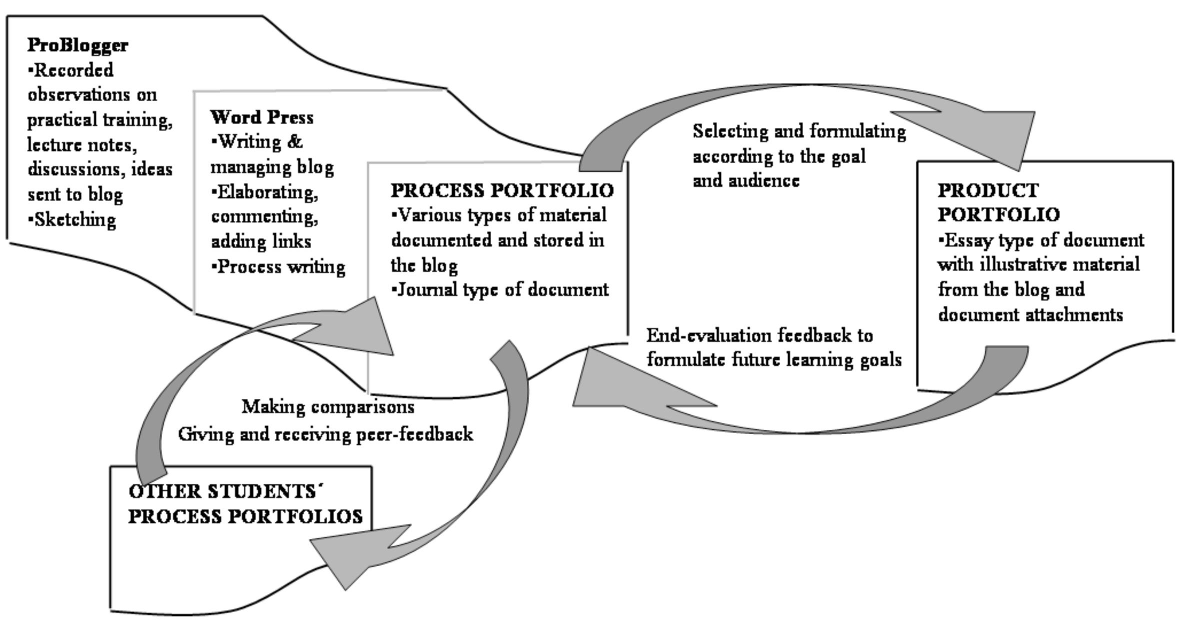

Figure 2. Process and Product Portfolio development activities with ProBlogger and Word Press weblog.

The processes described in the Figure 2. reflect various kinds of learning activities from reflective to non-reflective and products of these activities are documented in the process and product portfolios. It can be argued that through these documented products some of these activities can be traced. For example, examining whether the student processed initial observations or thoughts recorded with the ProBlogger into more thorough weblog entries, or whether the peer-feedback given as comments to weblog entries been noted in later entries. Additionally, it could be possible to examine whether the student has referred to other students' weblog entries and whether some of the material been used in the product portfolio. However, a more precise view of these processes and their products can be obtained after the process and product portfolios are ready to be analysed in April 2007.

4 Methods

Fourteen prospective history teachers at University of Tampere, Finland, are currently developing a personal digital portfolio. The digital portfolio tools are still under development, as is the instructional procedures involved in the personal digital development project. Therefore the structure of the study at hand is informed by design research (Collins, Joseph & Bielaczyc 2004). Design research has been described as being iterative, process focused, interventionist, collaborative, multileveled, utility oriented and theory driven (Cobb, Confrey, diSessa, Lehrer & Schauble 2003). Design research takes a progressive refinement approach by putting a first version of a design into the world to see how it works. Then, the design is constantly revised based on experience, until all the found problems are worked out.

In design research it is appropriate to apply multiple methods in order to gain full understanding of the problems and how to solve them. Also, the division between the three broad research types: theoretical, empirical and design research is not clearly cut. As Niglas (2004) has pointed out, it is essential that empirical as well as design research studies elaborate on at least some relevant theoretical ideas. On the other hand, design studies often include a small-scale empirical investigation, for example, at the stage of evaluation or problem analysis. Furthermore, there are certain research designs, like evaluation and action research studies, which are more or less on the borderline of empirical and design research.

The approach to design research taken here involves integrating afore mentioned design research procedures (Cobb et al. 2003) into other methods in order to enhance inquiries. The methods used during the development phases are questionnaires and structured interviews. Also, the process portfolio content accumulated in the on-line weblog process portfolio and the product portfolio will be analysed. To obtain information on the acceptance of the implemented tools, the students will respond 3 times (November 2006, February and April 2007) to a questionnaire with open-ended questions on experiences and variables on computer anxiety, technology acceptance and learning orientation during the academic year's trial. The student interviews will take place in April 2007. The questionnaire material will be reported in detail after the students have responded 3 times to the questionnaire. Also, a more detailed content analysis will be carried out on the material in the process and product portfolios.

The aim of the research project is to study authentic information gathering and knowledge acquisition as forms of reflective activities in personal portfolio development. However, as the study is still on-going and majority of the research material is yet to gather and analyse, the following preliminary results address the following research question:

• How do the experiences of use of the digital portfolio tools develop during the academic year?

5 Preliminary results

In November 2006, 14 students responded to the questionnaire after using the tools for 7 weeks. The students reported having considerable technical difficulties with the ProBlogger. Regardless of these problems, the students have been actively using the weblogs on desktops to write down their experiences. The students felt the use of weblogs was useful, although the link to producing product portfolios was unclear to them. The students regarded commenting each others experiences in weblogs as especially useful. Due to the technical issues (connecting to GPRS and WLAN networks, failure to setup ProBlogger to send entries), the students could not see added value in using the ProBlogger.

Again in February 2007, the students responded to the questionnaire. The students reported the use of Word Press weblog and the ProBlogger having strengths and weaknesses in supporting reflective learning and portfolio development (see Table 1).

Table 1. Strengths and weaknesses of Word Press and ProBlogger in portfolio development.

Strength: Word Press	**Strength: ProBlogger**
• Helps to assemble your thoughts, ready material that you can use, convenient as a diary/taking notes/archive, prevents you from forgetting things as there are no papers to lose	• Always with you, sending and storing material online is fast, possibility to do it just when you get an idea or are in the situation
• Good for reflecting, sharing knowledge and experiences, keeping the reflective process regular, getting comments keeps learning active and motivated, also comparing own reflective process to others helps	• Good way to amass material to process portfolio
• Good for following your own development	• Good way to store material for later reflection
• Possibility to communicate and the community aspect: read others blogs and discuss (especially those you have not seen for a while)	• Good way to get visual material to your portfolio
• Seeing that others are struggling with the same problems, getting teaching tips, getting comments, seeing the bigger picture	• Good for doing short reflections, writing notes
• Convenient for processing material and adding later thoughts in weblog entries	• Easy to use
• Easy to use entries references in the product portfolio	
• Sorting the material in categories, making links to websites and resources on-line: no need to search for them again	
• Easy to use	
Weakness: Word Press	**Weakness: ProBlogger**
• Others can see your blog, which causes self-censorship	• Privacy (everything is public when sending an entry to weblog through the ProBlogger)
• Would be good to decide on a single blog entry, whether it is public or some predefined person can see it	• Bugs in the ProBlogger software, technical problems in the beginning killed the interest, character limit of 1000 in one entry is not enough!
• Not possible to do your product portfolio using the same weblog	• Need possibility to read and comment others weblogs (not just send entries to ones own weblog)
• Effectively useless if you have problems with network	• Need to attach other documents to an entry (not only a photo)
	• No need for it (possible to write blog entries with a PC)

Although these findings reflect mainly positive views towards using the devices to support reflective learning and process portfolio activities, major issues were found that should be taken into focus of future development of the process portfolio system. Concerning Word Press weblog use, the possibility to manage flexibly who can read a single post entry and to produce the final product portfolio were mentioned. Concerning ProBlogger, there were issues regarding privacy and support for broader learning activity needs. These same problems were also present in earlier trials done with blogging tools to support teacher trainees learning in the field (Divitini, Haugaløkken & Morken 2005). Privacy was a problem when using ProBlogger as it did not support sending weblog entries as private, but they were instantly published. Also, the students felt they could have used mobile blogging more diversely in process portfolio development, as attaching various documents processed on the smart phone, reading and commenting other students' weblog entries. Mostly the problems experienced with the smart phone were reflected to the use of ProBlogger. Students reported the keyboard as being inconvenient for typing long entries, the device as unfamiliar and big, GPRS-network of being too slow and hoped the quality of the photos to be better.

After this introductory research into the pedagogical procedures, the investigation will move from this design-driven approach to a more empirical research approach with new history student and control groups to learn of the effects of the implementation and differences in information discovery and use in personal portfolio development.

6 Conclusions

The findings of an earlier study in this research project have advocated meaningful use of mobile technology to support authentic information discovery and use in learning tasks. The present design-driven stage of the research is concentrated on developing pedagogical procedures to take full account of the implemented tools. In the following academic year, the emphasis will be on more controlled empirical research in order to find the effects of the implementation and differences in information discovery and use in personal portfolio development.

As the preliminary results suggest, blogging shows promise as means to record one's own experiences for portfolio reflecting. However, both the mobile blogging technology and the ways of using it as a tool for learning still need to develop. Students appear to find it interesting but they are still unclear as to how they can best utilize this technology. The mobile tool needs to be more flexible to give room for personal preferences, e.g. it should enable storing blog entries also privately on-line. More emphasis should be placed on student collaboration in their information gathering and portfolio development. This means inspecting different ways of giving each other feedback on the process portfolios face-to-face and on-line, and how it contributes to the development.

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Students' Expectations of Data Security, Mobility and Computer-Supported Collaborative Learning on a Wireless Campus

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Recent developments in mobile technology have initiated new practices in teaching, studying and learning (TSL) processes. This article presents students' expectations concerning data security, mobility and computer-supported collaborative learning (CSCL) on a wireless campus at the University of Lapland, Finland, where incoming students since fall 2004 have been given the opportunity to acquire a laptop computer through the University. A wireless local area network (WLAN) has also been launched on campus. In addition to students' expectations the correlation of features of students' background information with their expectations are examined. Before the laptop computers and wireless network were introduced, data was collected by means of a questionnaire, in which students' background information, expectations were queried. There were also open questions concerning students' expectations of using laptop computers and WLAN in teaching, studying and learning as well as the strengths, weaknesses, opportunities and threats (SWOT) they anticipated the laptops and WLAN to have. The questionnaire was aimed at the 628 students who started their studies at the University of Lapland in fall 2004. Responses were obtained from 197 students and they were analyzed quantitatively, written answers were analyzed qualitatively. Results show that students expect studying and learning on a wireless campus to be mobile and data secured. Students also expect to be able to take part in computer-supported collaborative learning. The main influencing factors behind the expectations seem to be students' positive images of using computers, software and the Internet, previously gained basic computer skills and their age.

Keywords: mobility, computer-supported collaborative learning (CSCL), data security, laptop computers, students' expectations

1 Introduction

In recent years, the use of mobile technology in education has been increasing intensely since mobile devices, such as multimedia cell phones, iPods, personal digital assistants (PDAs), tablet PCs and laptop computers, have become more affordable and easier to move around. The term mobile learning has also emerged; it refers to studying and learning which is supported by mobile technology. Students are not necessarily bound to a classroom in order to take part in different courses, but studying activities can take place almost wherever a student happens to be at that moment. Materials, teachers, tutors, other students and learning environments can be reached from any place where a network connection is available.

Using mobile technology is often expected to have certain advantages in educational settings. These expectations are supported by positive research findings showing that mobile technology may, for example, enable continuity between learning contexts, adaptability and accessibility, time and learning management, and also flexible interaction (Hoppe, Joiner, Milrad, & Sharples 2003). Lately, however, it has been acknowledged that technology alone does not do the

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trick; introducing technology in education needs careful planning and a clear view of the purpose for using technology (Goldberg, & Riemer 2006). Recent research findings indicate that in addition to advantages, mobile technology may also diminish the fluency of studying (Waycott, & Kukulska-Hulme 2003). Moving and carrying around laptop computers, for example, can make them more fragile and the battery duration and the capacity and security of the wireless network may not yet meet utilization requirements (Isomäki, Päykkönen, & Räisänen [in press]).

While challenges are acknowledged, whole wireless campuses have been and are being developed to support students using their mobile devices and to enhance information and communication technologies' (ICTs) pedagogical use. This paper describes a wireless campus initiative taking place at the University of Lapland, Finland, where incoming students have been given the opportunity to acquire a laptop computer through the University since autumn term 2004. Additionally, at the end of 2004 a wireless local area network (WLAN) was launched on campus.

The goal of this article is to describe students' expectations of data security, mobility and computer-supported collaborative learning (CSCL) on a wireless campus. It also examines what kinds of correlations exist between students' expectations and students' background information (cf. Räisänen 2005). This paper is a part of a case study called 'The utilization of laptop computers and wireless local area network'. The case study is a part of the MobIT (Developing Mobile Network-based Teaching, Studying and Learning Processes) research project. The project is funded by the Ministry of Education and altogether it comprises three case studies in which the use of mobile technology, such as laptops and a wireless network, in teaching, studying and learning is studied (Räisänen, Lehtonen, Ruokamo, & Isomäki 2005).

Following, the theoretical background and research questions are introduced. After that, the methods of research, data collection and analysis are presented. Finally, the research findings are presented and discussed.

2 Theoretical Background and Research Questions

Previous research on laptop initiatives report positive outcomes (Varvel, & Thurston 2002). Accordingly, distributing laptop computers to each incoming full-time student may help diminishing the digital divide between genders and generating positive attitudes about the state of technological readiness. Students find laptops to be beneficial during their studies (Finn, & Inman 2004). Laptop computers made a significant difference in students' study habits and to their academic and social lives. Students found the laptops helped with classroom assignments, interaction and research (Demb, Erickson, & Hawkins-Wilding 2004; Nicol, & McLeod 2005).

Positive experiences build up positive expectations, but it also needs to be noticed that students are already quite computer savvy when they commence their studies since they are used to using, for example, mobile phones and multimedia players. Students have some kinds of perceptions of mobile technology and are thus able to lay expectations on using it in education. Research about students' expectations of laptop initiatives in particular show that men expect laptop computers to help them with finding information and with individual tasks. Women expect to achieve high quality learning through interactive collaboration (Saunders, & Quirke 2001).

In this case, students' expectations of mobility, data security and CSCL are studied. Studying and learning are thus seen as taking place in CSCL communities, which means that students are members of a studying and learning community that uses mobile ICTs i.e. laptop computers and WLAN, as mediating tools for social interactions and collaborative methods within studying (Kirschner, Martens, & Strijbos 2004; Stahl, Koschmann, & Suthers 2006). Mobility, perceived here as movability of devices (Luff, & Heath 1998) enables studying and learning also in situations when all members of a studying community are not in the same place, not even in the same country. Studying and learning are used here separately to accent students' active role in the teaching-studying-learning (TSL) processes. Teaching does not directly lead to learning, but needs students' own activity before learning can be attained (Uljens 1997; Kansanen, Tirri, Meri, Krokfors, Husu, & Jyrhämä 2000).

The key to successful learning in CSCL is to support maintaining dialogical culture and convergent goals by means of technology. This is why one particular feature of mobile ICTs – data security – is taken as one discussion topic. Developing collaborative network-based TSL environments should raise questions about security issues, even though it has been missing from CSCL research. Only quite recently has there been research of security solutions in mobile learning (Kambourakis, Kontoni, Rouskas, & Gritzalis 2007) and of user experience of security in mobile collaborative learning (Isomäki, & Räisänen [paper in progress]). Data security is perceived here as an experienced feature of mobile network-based studying and learning environments that enables secure collaborative studying and learning practices and promotes students' sense of community, which is essential for collaborative learning (Allan, & Lewis 2006; Dourish, Grinter, Delgado de la Flor, & Joseph 2004).

The research questions of this study are:

1) What kinds of expectations do students have concerning data security, mobility and computer-supported collaborative learning on a wireless campus?
2) Which features of students' background information correlate with their expectations?

3 Research and Data Collection Methods

The data was collected by sending a questionnaire to all 682 students who started their studies at the University of Lapland in fall 2004, before the laptops and WLAN were introduced. It was considered to be important to chart students' expectations before they began using the devices because getting and using the laptop could change their expectations. (Räisänen et.al. 2005.) However it has to be noted here that the laptop initiative was widely reported in newspapers and education related exhibitions, which most likely has had some effect on expectations. Before the questionnaire was delivered to students it was tested, and overlapping questions were removed and the questionnaire was shortened.

The questionnaire was accompanied by letter, in which the research topic was introduced and students were asked for informed consent (cf. Sieber 1992). In the questionnaire, students were asked about background information, previous experiences and expectations regarding the use of computers and networks in studying and learning, and how they reconciled the demands of studying and family life. There were also two open questions about students' expectations of teaching, studying and learning with laptop computers and WLAN and also two questions about the possible strengths and opportunities, weaknesses, and threats (SWOT) that students expected the laptops and WLAN to have. Statistical replies were saved by using SPSS for Windows software and analyzed statistically. Open ended questions were read and categorized; the answers are used here along the statistical data to support and to give depth to statistical analysis.

A total of 197 students returned questionnaires, which is 29% of the whole population. The amount of answers is small, which must be taken into consideration when discussing the results, but on some parts it can be considered to be reasonably representative of the overall population. There are both men (22%) and women (78%) among the respondents from all the five faculties of the University of Lapland. The distribution between women and men is the same in the whole student population who started their studies at the University in fall 2004. The mean age of the respondents is 24 years. The youngest respondent is 19 years and the oldest 58 years old. The size of the response rate can be affected by the fact that the questionnaire was rather long even though it was shortened before it was delivered to students. It was handed out to students at the student orientation arranged by the faculties, this may well have influenced the response rate because it is a time when students are typically inundated with information and the schedule during those first days of the autumn term is quite hectic, so there was not a lot of time to answer the questions. It would have been possible to try to increase the response rate by repeating the inquiry, but that might have twisted the results because the laptop computers were delivered to students from the first week on.

4 Results

4.1 Students' expectations

The first research question was: What kinds of expectations do students have concerning data security, mobility and computer-supported collaborative learning on a wireless campus?

Firstly, four items describing students' expectations of data security were selected from the questionnaire and transformed into sum variable through reliability test. These four items are 1) "Using a laptop and networks is confidential (data security)", 2) "It is possible to use a laptop and networks to search for and save information from networks privately", 3) "When using a laptop and networks I can store my files in a way that others don't have access on them" and 4) "When using a laptop and networks virus protection and firewall software protect my information". Cronbachs' alpha of the sum variable is 0.80 (α=0.80), which indicates that the variable is reliable and can be used as descriptive of students' expectations of data security.

Secondly, five items describing students' expectations of mobility were selected and transformed into sum variable. These five items are 1) "By using a laptop and networks studying becomes more independent of time and place", 2) "Using a laptop and networks changes the time management of studying", 3) "Using a laptop and networks makes studying flexible", 4) "Using a laptop and networks changes time management and the amount of spare time" and 5) "With the help of a laptop and networks it is possible to study in more versatile locations than before". Cronbachs' alpha of the sum variable is 0.75 (α=0.75), which indicates reliability that enables further analysis.

Finally, five items describing students' expectations of CSCL were selected and transformed into sum variable. These items are 1) "With the help of laptops and networks it is possible to do group assignments with other students in the same classroom", 2) "With the help of laptops and networks it is possible to do group assignments via email or in a network-based learning environment", 3) "With the help of laptops and networks it is possible to work on the same document on a synchronous distance connection", 4) "With the help of a laptop and networks it is possible to publish and forward information to others" and 5) "With the help of a laptop and networks it is possible to work on ideas with other students". Cronbachs alpha of the sum variable is 0.85 (α=0.85), which shows that variable can be reliably used as descriptive of students' expectations of computer-supported collaborative learning.

The frequencies of students' expectations of data security, mobility and CSCL are presented in Table 1.

Table 1. Students' expectations of data security, mobility and CSCL

Expectations / Likert scale	Data Security	Mobility	Computer Supported Collaborative Learning
1 (Not at all)	1%	0.5%	0.5%
2 (A little)	3.6%	12.5%	16.2%
3 (Some)	16.7%	40.8%	45.0%
4 (Quite a lot)	49.0%	40.8%	29.3%
5 (A lot)	29.7%	5.4%	8.9%

Almost half of the students, 49% expect quite a lot that studying and learning on a wireless campus is data secure. However, data security was not mentioned in open answers about expectations of teaching, studying and learning. It might be that data security is perceived as a ubiquitous part of studying and learning on a wireless campus since data security issues were the most mentioned threat or weakness in the SWOT analysis, which means that data security is not insignificant.

Laptop may be stolen or someone might hack into my laptop or misuse my information. (Student 157)

Of the respondents, 40.8% expect some or quite a lot to be able to be mobile when studying. High expectations regarding mobility can also be seen in written answers concerning expectations of teaching, studying and learning and also in the 'strengths and opportunities' section of the SWOT analysis. Students' embrace the fact that they have the opportunity to study more personally and flexibly regarding time and place and combine studying with work and family-life more effectively. Students also envision their laptops to become a seamless part of their studying and learning.

In practice studying becomes easier and the laptop proceeds my studies remarkably (I have a family, children are 4 and 6 years old, no computer at home). I can study at the time it suits me the best (towards midnight). (Student 108)

I believe that the laptop will become a part of me. (Student 071)

On the other hand, some students realized also the responsibility that increased freedom brings about, which can be seen in some answers in the 'weaknesses and threats' section of the SWOT analysis. It also noted that when "the University comes home with you" it is more difficult to relax and separate studying from free time.

The illusion that studying can take place whenever brings about the danger that studying doesn't happen at all since one can imagine being able to postpone the work forever… (Student 073)

Studying is always with you. One might not be able to relax as should. (Student 183)

Of the respondents, 45% have some expectations concerning CSCL. This quite neutral standing could also be seen in open answers and in SWOT analysis. The ability to receive materials and information through the laptop and WLAN was perceived positively and also the ability to interact in a more flexible manner with teachers and other students. However, studying and learning in computer-supported communities was not perceived totally positive, some students also mentioned fearing that studying and learning through networks might hinder social interaction and communality.

The WLAN opens doors to a wider community. (Student 119)

It is possible to have studying material in electronic form […] interactions become more effective and assessment accelerates. (Student 070)

It is possible to recede from other students and have lesser contacts with other people. (Student 142)

4.2 Features of students' background that correlate with their expectations

The second research question was: Which features of students' background information correlate with their expectations? In the questionnaire, students were asked for some background information about their age, gender, faculty, previous experience of desktops, laptops and different kinds of software and also previous experience of network-based studying and learning. Students were also asked if they work in parallel with their studies, about their marital status and if they had children or not. In addition to these variables there were also several items concerning students' skills in using different kinds of hardware, software and networks. According to Osika and Sharp (2003) students should have skills to be able to use computer operations and utilities, file management, word processing, the Internet, presentation graphics, spreadsheet and databases.

When reviewing the correlation ratios that describe the connections between the expectations and background information, there are three factors of students' background information that have an effect on their expectations: 1) positive images of using computers, software and the Internet, 2) age and 3) previously gained basic computer skills. When comparing these results to the study of Saunders and Quirke (2001), there was a difference in that gender did not play an influencing role in students' expectations. One might have hypothesized that the faculty where students begin their studies could have had an impact on their expectations, but according to these results this was not the case.

In the questionnaire, there were eight items concerning students' feelings towards using computers, software and the Internet: 1) "Computers and software are easy to use", 2) "I like using computers", 3) "I like using the Internet", 4) "Using a laptop computer and networks is easy", 5) "Using a laptop and networks brings me joy", 6) "Using a laptop and networks makes studying more interesting", 7) "Using a laptop and networks makes me satisfied" and 8) "Using a laptop and networks in studying motivates me". These items were transformed through reliability test into a sum variable describing students' general positive images of using computers, software and the Internet. Cronbach's alpha of the sum variable is 0.83 (α=0.83).

There were five items describing students' basic computer skills in the questionnaire: 1) "I have used word processor software", 2) "I have used presentation graphics software", 3) "I have used spread sheet software", 4) "I have used an Internet browser" and 5) "I have searched information on databases". These items were transformed through reliability test into a sum variable describing students' previously gained computer skills; Cronbach's alpha being 0.73 (α=0.73).

As mentioned earlier, the mean age of the respondents is 24 years. The frequencies of the other two features effecting background are presented in Table 2 below.

Table 2. Frequencies of students' previously gained basic computer skills and positive images of using computers, software and the Internet

Background information / Likert scale	Previously gained basic computer skills	Positive images of using computers, software and the Internet
1 (Not at all)	0.0%	0.5%
2 (A little)	13.1%	4.1%
3 (Some)	41.4%	22.2%
4 (Quite a lot)	38.2%	57.7%
5 (A lot)	7.3%	15.5%

Less than a half, 41.4%, of the students have some basic skills that are needed when using typical office software or common network services. This result confirms the results presented by Osika and Sharp (2003). They state that although students are introduced to technology at an early age, they still do not necessarily have all of the skills required to be successful with network-based education. Here it needs to be noted that particularly older students have not necessarily had lots of experiences with computers and networks, which may influence these results even though ICTs are commonly used also in working life. But even though the level of respondents' skills is not very high, 57.7% of them have quite a lot positive images of using computers, software and the Internet.

The results of the analysis describing which features of students' background information correlate with their expectations are presented in Table 3 below.

Table 3. Correlations with students' background information and their expectations

		Expectations of data security	Expectations of mobility	Expectations of CSCL
Positive images	Pearson Correlation	,465(**)	,461(**)	,394(**)
	Sig. (2-tailed)	,000	,000	,000
Previously gained basic computer skills	Pearson Correlation	,307(**)	,103	,346(**)
	Sig. (2-tailed)	,000	,180	,000
Age	Pearson Correlation	,157(*)	,205(**)	,191(*)
	Sig. (2-tailed)	,040	,007	,013

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

According to this study, expectations of data security may be explained by positive images *(r=0.465, p=0.01),* previously gained basic computer skills *(r=0.307, p=0.01)* and age *(r=0.157, p=0.05).* Positive images have a moderate, positive and statistically significant correlation with expectations of data security. Previously gained basic computer skills have a weak, positive and statistically significant correlation with expectations of data security. Age has a weak, positive and statistically almost significant correlation with expectations of data security. Having positive images and previous basic computer skills seems to increase the expectations of the data security of studying and learning on a wireless campus. Also, the older the students are, the more they expect data security.

Expectations of mobility may be explained by the students' positive images of using computers, software and the Internet *(r=0.461, p=0.01)* and by the students' age *(r=0.205, p=0.01).* It can be said that both these background features have a weak, positive and statistically significant correlation with expectations of mobility. The more positive images the students have or the older they are, the more they expect studying and learning on a wireless campus to be mobile.

Expectations of computer-supported collaborative learning may be explained by positive images *(r=0.394, p=0.01)*, previously gained basic computer skills *(r=0.346, p=0.01)* and age *(r=0.191, p=0.05).* Positive images have a moderate, positive and statistically significant correlation with expectations of CSCL. Previously gained basic computer skills have a weak, positive and statistically significant correlation with expectations of CSCL. Age has a weak, positive and statistically almost significant correlation with expectations of CSCL. Though according to these results it seems again, that having positive images and previous basic computer skills evoke expectations of CSCL. Furthermore, the older students are, the more they expect from CSCL.

5 Discussion

The purpose of this article was to describe students' expectations of data security, mobility and CSCL on a wireless campus. The aim was also to scrutinize which students' background features might explain their expectations. When reading the results it needs to be remembered that these can be generalized with caution because of the small response rate.

From the empirical data it is possible to identify that students expect quite a lot that studying will be data secure. Data security is mostly mentioned through data security threats, such as viruses and hackers, not so much as a positive feature that enables the creation of the sense of community and secure computer-supported collaborative learning. Students also have some or quite a lot of expectations that they will benefit from the mobility enabled by laptop computers and the wireless network. In students' minds mobility relates to the movability of devices, such as it is seen in the article by Luff & Heath (1998). Hoppe et al. (2003) anticipated that wireless handhelds might promote setting the focus of studying and learning on interpersonal relations and the task as the technology moves to the background. These kinds of expectations can be seen also in this study as students expect the laptop to become an embedded part of their studying and to be able to study in various locations and at various times in a way that suits their individual habits and situation in life. Finally, students have some expectations of computer-supported collaborative learning. These expectations were the most neutral of the three. The most mentioned benefits were being able to interact and do group assignments through laptops and WLAN more flexibly with a possibility to access a wider student community, which follows the basic idea of CSCL (Stahl et al., 2006). Teaching, studying and learning through networks was seen as a positive opportunity but also as a possible threat that might lessen social contacts with other students, professors and teachers.

There were three background factors that stand out as influencing students' expectations: 1) general positive images of using computers, software and the Internet, 2) previously gained basic computer skills and 3) age. The most influential factor of these three is general positive images, which is a slight surprise. Then again, it has already been acknowledged in previous research that emotional factors have an influence on studying, learning and on the creation of community (Hyvönen, Lehtonen, Ruokamo, & Tella 2005; Jones & Issroff 2005).

Another important factor behind students' expectations is having previously gained basic computer skills. The more skills a student has, the more positive expectations she or he has about data security and CSCL. This seems logical since having computer skills may also diminish possible fears a student might have of computers and technology in general and thus is able to have positive expectations. Age also seems to have an effect on expectations. One reason for this might be that many students work besides their studies and some also have families. Network-based courses and mobility enable them to create their own schedules and help them divide their time between studying, working and family-life. Also, the mean age of the respondents enrolling in the University was 24 years which indicates that many of them have previous studies that they have taken since graduating from high school. Thus they may have additional personal studying skills which help them to be more active and independent during their studies.

In this case, questionnaire was selected as means to acquire knowledge about students' background information and expectations. As the population was quite wide, using statistical data collection and analyzing methods was justified but it turned out that using also written answers to open questions was beneficial to the analysis since it enabled gaining the kind of knowledge that would have been otherwise missing from the analysis.

The results help planning future laptop or other mobile technology initiatives taking place in higher education. Studies that precede higher education should ensure that students have the skills needed when enrolling in studies using mobile technology. In addition to having basic skills in using computers and networks, gaining positive experiences of success with computers and networks is important. This might contribute to positive images of using computers, software and the Internet and thus help in diminishing fears and prejudices towards computers and networks.

This article is a part of a larger investigation of the laptop initiative in the University of Lapland and it should be considered as an opening for future research. Following, students' experiences of mobility, data security and computer-supported collaborative learning on a wireless campus will be examined in the second case study of the MobIT project. Of particular interest is the role of data security in CSCL, which needs further investigation.

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