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Abstract:
The purpose of the document is to analyse the current practices of using ICT and CSCL in European education, crystallize and concretise pedagogical ideas of collaborative knowledge building to guide the design of ITCOLE CSCL, and provide good examples and models for pedagogical practices.

The document is based on CSCL research literature review and information about current practices of using the Internet and networked learning environments for instructional purposes in the participating countries.

Keywords :
Computer-supported collaborative learning, CSCL research in Europe, implementation of CSCL in schools, progressive inquiry.

Related documents:
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Perspectives of CSCL in Europe: A Review

Introduction

A widely experienced concern in western societies is how it is possible to prepare future generations to cope with cognitive, social, and motivational challenges of the emerging knowledge based society. Historically a similar question has concerned educationalist during all notable technical or cultural changes. When printed books became more frequent, educational theorist anticipated that only a small portion of population is smart enough to learn reading. A few decades ago computer literacy was supposed to be possible for a minor specialist group only. Although the history shows that cultural evolution provides humankind with the skills and knowledge needed in coping with changing historical situations, one can ask if the rate of change in information society is accelerated too much.

An obvious educational challenge emerging from the knowledge society is the need to train citizens to use technical tools such as computers, information networks, multimedia, and virtual realities that constitute the most concretely visible part of the knowledge society. Surviving in the emerging knowledge society requires that each citizen is able to productively function in a high-tech environment. Only a part of the European population has an access to information technology. There are significant differences between people in their access to and skills of using the information and communication technology (ICT) in terms of their socio-economic position, life situation, and age.

It appears to us that the skills of using the new technology and searching of new information (i.e., basic information skills) is not enough, but people need more advanced skills for acquiring knowledge, and using it meaningfully in different contexts (knowledge acquisition skills). In other words, network-based operating practices are not only about possessing the skills to use information technology hardware and media, but also of possessing more general skills of collaboration, information processing, and communication. The essential element in these skills is ensuring that the information acquired through the networks be understood and transferred into usable knowledge by connecting it to meaningful contexts. This means that a relatively large share of students leave the school with insufficient skills to comprehend complex texts and to evaluate and elaborate propositions presented in texts.

The main objectives of ITCOLE project are to develop pedagogical models of collaborative knowledge building for European education, to develop a modular knowledge-building environment to support collaborative learning and to evaluate, test and disseminate the environment in European schools in order to build meaningful pedagogical practices and to advance the use of collaborative learning technology. The project aims to contribute to scientific and technical know-how about whether collaborative building of knowledge with the help of new technology could be used to facilitate better learning achievements and development of new cognitive competencies in European education. The objective of the project is on developing and testing innovative pedagogical models, design principles, and learning scenarios of collaborative knowledge building in European education.

The purpose of this review is to fulfil the aims of analysing the current practices of using ICT and computer-supported collaborative learning (CSCL) in European education, crystallize and concretise pedagogical ideas of collaborative knowledge building to guide the design of ITCOLE CSCL software, and provide good examples and models for pedagogical practices. This review is based on information about current practices of using the Internet and networked learning environments for instructional purposes in the participating countries. The review collects and shares knowledge and experiences of the CSCL researchers taking part in the project.

The review starts with a theoretical description of the pedagogical research and development in the context of CSCL in general. Synchronous communication and its possibilities in education has been described in a separate chapter, because one of the pedagogical research partners in ITCOLE project has a long experience in studying it; synchronous tools will also be one of the new technical innovations that will be implemented in ITCOLE software. Chapter 3 provides an overview of the current situation in the CSCL research in Europe. Overview is based on the First European Conference on Computer Supported Collaborative Learning (Euro-CSCL) held at the University of Maastricht, the Netherlands on March 22-24, 2001. The conference provides an excellent window to the latest development of innovative learning technology in Europe.

All four pedagogical research groups have written their own chapters of the state-of-the-art of ICT and CSCL in education in their own country. We have structured the chapters in a unifying way, but otherwise we have respected each partners' own unique way of describing the situation and development in their country, because we think that it gives a more genuine view of the situation. In addition, in the end of a review there is a general concluding chapter, where we have outlined the most important results and challenges in the research and development of using ICT and CSCL in European education, and the main guidelines for developing the pedagogical models and design principles in the ITCOLE project.

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1. Supporting Collaboration with Computers

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Throughout history, our conceptions about human cognition and learning have been related and shaped by the development of technology (Bolter, 1984). This parallelism between our psychological understanding and the technologies available is clear in the field of computer-supported collaborative learning (CSCL), where technology meets psychology, philosophy, and pedagogy. Instructional designers and software developers, educational psychologists, learning theorists, computer scientists, and even sociologists are interested in this rather new area of research.

1.1 What is CSCL?

It is hard to say when CSCL emerged as a separate field of study, or as an emerging paradigm of educational technology. The first CSCL workshop took place in 1991 (Koschmann, 1994), and the first international CSCL conference was held 1995 in Bloomington, Indiana. How should one define computer-supported collaborative learning? Put briefly, CSCL is focused on how collaborative learning supported by technology can enhance peer interaction and work in groups, and how collaboration and technology facilitate sharing and distributing of knowledge and expertise among community members. Partly, the inspiration for CSCL arose from the research on Computer-Supported Cooperative Work (CSCW). This research has revealed issues about the collaborative nature of work supported by groupware (Galegher & Kraut, 1990; Greenberg, 1991; Grudin, 1994).

Whilst talking about computer-supported collaborative learning one typically refers to the acronym CSCL, and does not speculate about the latter “C” word (the first stands for 'computer') and what it might stand for. The short history of CSCL shows, however, that there have been different interpretations and suggestions for the “C” word such as, collective (Pea, 1996), coordinated, co-operative, and collaborative (see Koschmann, 1994). There have been even different interpretations of the meaning of the whole acronym. The latest, computer support for collaboration and learning, pointed out by Koschmann (1999), suggests that we should link research on learning and working more closely to each other, as well as the research on the CSCL and CSCW. Despite the different interpretations of the “C” word and the acronym, most researchers appear to use them nowadays as already suggested by Koschmann in 1994. He proposed “the best policy might be to simply use the acronym, allowing individual interpretation of what the letters might be" (1994, p. 220).

This conversation about the meaning of the acronym is related to the central questions concerning CSCL such as: What are we studying when we are studying collaboration supported by technology, and, what should we be studying? It is not an easy task to answer to these questions. As stated earlier, some researchers propose that we should study very specific interactions of mutual engagement and intimacy. Dillenbourg (1999) suggested that one should not talk about the effects of collaborative learning in general but more specifically about the effects of particular categories of interactions. One should, for example, analyse a posterior which interactions did actually take place during collaboration (Dillenbourg, 1999, pp. 16-17), for instance, to study the sequences of improvement and refinement of ideas, and focus not so much on individual statements in discourse (Stahl, in press). In other words, one should zoom in more intensively on the micro level in collaborative interactions.

If the studies concentrate only on the interactions of mutual engagement one can then ask, what is the relevance of CSCL research at schools, or in workplaces in general. How should we analyse collaboration at the collective (macro) level? To date, there is no consensus about the unit of analysis, whether it should be individuals, dyads, groups, communities, or as argued by Bereiter (in press), collaboratively produced knowledge objects or conceptual artefacts. All these units of analysis have been used in the studies that go under the label of CSCL, the unit of analysis depending on the theoretical background and definitions of 'collaboration' used.

If one reads through the recent papers published in CSCL research (e.g., Dillenbourg, Eurelings, & Hakkarainen, 2001; Hoadley, 1999) most of them appear to rely on the wide sociocultural framework. But, as Sfard (1998) reminds us, the metaphors of learning, acquisition and participation, should not be mistaken for the dichotomy between individual and social dimension of learning. All the various forms of socially oriented learning (see, Salomon & Perkins, 1998) cannot be considered as representatives of the participation metaphor; they are better interpreted through the acquisition metaphor. Instances of the latter are those theories that rely heavily on the idea of intersubjectivity or internalisation. To clarify the issues is how Vygotsky's ideas have been understood in the CSCL research, and in the learning sciences in general. Some interpret Vygotsky's ideas in a very traditional way: that cultural processes give rise to individual cognition, and collaboration is a source or facilitator of individual learning (see Salomon & Perkins, 1998; Sfard, 1998); essentially this is an acquisition approach, despite the social dimension. On the other hand, Vygotsky's concepts are interpreted as antecedents of distributed cognition and situated learning (Cole & Wertsch, 1996); and this approach is based on participation. Or consider the concept of sociocognitive conflict proposed by the neo-Piagetian researchers (see for instance, Doise & Mugny, 1984); it clearly represents the acquisition metaphor of learning. At this moment, CSCL research seems to utilize both metaphors of learning as well as those approaches that do not fit either of these metaphors, such as knowledge building (Bereiter, in press).

In sum, even if the stress in CSCL research is on socially oriented theories of learning, there is still no unifying and established theoretical framework, no agreed objects of study, no methodological consensus, or agreement about the unit of analysis. Positively considered, this ambiguity can be seen as reflecting the richness or diversity of the field. Negatively interpreted, it seems that the field is proceeding along increasingly divergent lines. In 1996, Koschmann (1996) recognized CSCL as an emerging paradigm of educational technology. If we concur that in an established scientific paradigm, the theories and methods as well as objects of study are agreed, it is not an exaggeration to say that CSCL is an emerging educational technology paradigm.

1.2 Challenges and advantages of CSCL

Collaboration can be supported with very different instructional ideas and computer applications. Crook (1994), for instance, has proposed four kinds of interaction in which computers play a part: 1) interactions at the computers, 2) interactions around computers, 3) interactions related to computer applications, and 4) interactions through computers. In the following paragraphs, I concentrate on the fourth issue, interaction, and collaboration through computers.

The first three aspects proposed by Crook are face-to-face interaction situations where meanings are mediated through spoken language, faces, and gestures. In these situations, computers can act as a referential anchor, and mediate the coordination of attention and collaborative actions (Crook, 1994; Järvelä, 1998; Järvelä, Bonk, Lehtinen, & Lehti, 1999; Roschelle, 1992). By contrast, collaboration through networked learning environments is still mainly based on written language, as in the case of Computer-supported Intentional Learning Environments (CSILE; Scardamalia & Bereiter, 1991). Thus, interaction that takes place through computer networks lacks certain basic features of face-to-face collaboration: social cues such as faces, gestures and intonations of speech. It also lacks the rich referential field of the material world that is present in face-to-face interactions. The lack of referential anchors is quite pronounced in written communication. This means that explicating referential relations in a written message is important because, in written language, such explications of a message create context and grounding; in contrast these referents are usually known by participants or are easily checked in face-to-face discourse. Building a common ground is considered an essential part of coordinating collaborative activities and knowledge sharing (Clark & Brennan, 1991; Dillenbourg & Traum, 1999; Koschmann, LeBaron, Goodwin, & Feltovich, 2001).

The idea of collaboration as mutual engagement appears to imply synchronous activity or even a situation of face-to-face interaction. Hence, one may ask, how is this prerequisite for collaboration, mutual and reciprocal engagement, created through networked learning environments such as CSILE. Or is it possible at all? There are some initial attempts to analyse this phenomenon in asynchronous CSCL environments (see Järvelä & Häkkinen, in press a, in press b) but there is still a lack of evidence whether asynchronous computer-mediated collaboration is possible at all, and if it were, what expressions or communicative acts would be indicators of reciprocal interaction and understanding. From this perspective, one can presume that collaboration is a form of activity that seldom manifests in students' interactions in networked learning environments.

There are other challenges of CSCL: knowledge management problems with large databases, short discussion threads with divergence topics, and unequal participation patterns (Guzdial & Turns, 2000; Lipponen et. al., 2001; 2001a). According to Stahl (1999), the clearest failures related to computer-supported collaborative learning environments are that for different personal and cultural reasons students and teachers are hesitant to use them. Further, if the technology itself is put intensively into use, there still might be considerable difficulties in bringing about genuine collaboration and knowledge construction. Why has CSCL been so slowly adopted? As proposed by Kling (1991) in the context of CSCW, it might be that the meanings attached to collaboration are too positively loaded, or the collaborative settings are interpreted too narrowly referring only to positive phenomenon. This may restrict one from seeing, that collaborative situations are also full of contradictions, competition, and conflicts. A realistic picture of collaboration should also take these issues in to consideration. Only recently has the interest in overcoming the existing barriers of computer-supported collaborative learning grown (Lipponen, 1999; Stahl, 1999).

On the other hand, technology offers the kind of potentials for learning which are very different from those available in other contexts. A wave of empirical research has revealed a long list of the promises and reported benefits of computer networks for collaboration (see Lehtinen et al., 1999, for a review). One self-evident benefit is that computer networks break down the physical and temporal barriers of schooling by removing time and space constraints. The delay of asynchronous communication allows time for reflection in interaction. Making thinking visible by writing should help students to reflect on their own and others' ideas and share their expertise. Shared discourse spaces and distributed interaction can offer multiple perspectives and zones of proximal development (ZPD) for students with varying knowledge and competencies (ZPD is Vygotsky's famous notion; a distance between what learners can achieve independently and what can be achieved in the company of a more skilled collaborator). CSCL environments can also offer greater opportunities to share and solicit knowledge. Further, the database can function as a collective memory for a learning community, storing the history of knowledge construction processes for revisions and future use.

It is, however, a challenging task to compare empirical studies conducted under the label CSCL, because they differ from each other in several significant aspects. First, there is no agreement whether one should study effects of or effects with CSCL. Salomon, Perkins, and Globerson (1991) made educators aware of two ways of thinking about learning and technology. According to them, one should look at effects of technology, this is, what one has learned and can transfer from those situation working with computer. Yet one should also look at the effects with technology; what one could achieve in synergy with a computer. In the same sense one can speak about effects of CSCL; that is, because of interacting with others and computers, persons individually practice new competencies and gain knowledge that can be transfer to new situations. Or, by contrast, one may speak of effects with CSCL, referring to processes people and computers achieve in synergy.

Secondly, there is a variation in research procedures; in length of the study, in number of students participating, in students' age, and whether students worked individually, in pairs, or in small groups. Whilst analysing learning in CSCL settings, researchers have used different learning tasks, and have studied how special concepts are learned (Roschelle, 1992). They have analysed socio-cognitive effects of CSCL (Järvelä, Hakkarainen, Lehtinen, & Lipponen, 2000), complex reasoning and levels of argumentation (Hoadley & Linn, 2000), explored science learning and inquiry processes (Edelson, et. al., 1999; Hakkarainen & Sintonen, in press), collaborative knowledge building (Scardamalia, et al., 1994), studied cognitive and metacognitive understanding (Brown, Ellery & Campione, 1998), design processes (Seitamaa-Hakkarainen, Raami, Muukkonen, & Hakkarainen, in press), and motivational aspects in CSCL (Rahikainen, & Järvelä, 2001; Tapola, & al., 2001). Lately, stress is also put on issues of participation (Guzdial & Turns, 2000; Lipponen, et al., 2001). These are just few of the research topics that have emerged in the context of CSCL.

Thirdly, what makes the comparison even more difficult among different studies is that there exists a great variety in the technologies used; also in the purposes sought, and how some particular applications were used. Is students' collaboration supported around the computer (for instance, with simulation programs), or is it supported with networked learning environments (such as CSILE), and is technology used for structuring the collaboration or to mediate collaboration? The differences in methodologies and units of analysis applied have already been mentioned. Because of this ambiguity (or richness if you will) of the empirical studies in the CSCL research, we do not know exactly the circumstances in which one set of results can be extended to another context.

The boundless enthusiasm towards technology has made us researchers mainly focus on the potentials of CSCL. In some respects, this has blinded us, and made us to consider the potentials of technology and collaboration as empirical evidence for the actual benefits of CSCL. It is true that some very intensive studies have had success in promoting high-quality learning supported with computer networks (Hakkarainen, 1998; Lamon et al., 1996; Scardamalia, et al., 1994). However, on a large scale, there is no solid evidence that collaboration through networks leads to excellent learning results. Stahl (in press) has even proposed that CSCL environments are mainly used for exchange of personal opinions, and for delivering surface knowledge, not for collaborative knowledge building. In addition, we can also speculate whether some of these results achieved in the CSCL studies would have been achieved without any networked computer support. Among other constraints on the dominant research in CSCL is that there exists little research on how students participate in networked mediated collaboration, and on the consequences of different types of participation patterns, and how these are related to other aspects of CSCL, such as quality of students' discourse (but see Lipponen et al., 2001; 2001b).

1.3 What promotes learning in the context of CSCL?

Despite the controversial interpretation of the theories, methods, and technology that underlie CSCL, researchers appear to agree on those mechanisms that could promote learning in this context. There exist two main theoretical perspectives for a mechanism promoting learning in a CSCL setting. These perspectives trace back to the thinking of Piaget and Vygotsky. Because these approaches have been extensively reviewed in earlier studies (Crook, 1994; Dillenbourg, et. al., 1996; Doise and Mugny; 1984; Hakkarainen, et al., 1998; Littleton & Häkkinen, 1999; Palincsar, 1998) and a detailed analysis of the different forms of social learning is given by Salomon & Perkins, (1998), I shall only take a brief look to this issue. The first mechanism that is seen to promote learning in the context of CSCL is Piagetian socio-cognitive conflict. Children on different levels of cognitive development, or children on the same level of cognitive development with differing perspectives, can engage in social interaction that leads to a cognitive conflict. This "shock of our thought coming into contact with others" (Piaget, 1928, p. 204) may create a state of disequilibrium within participants, resulting to construction of new conceptual structures and understanding. According to this view, new knowledge is not so much a product of co-construction or shared understanding but is rather understood as taking place in the individual minds. This new understanding can then be brought back to the level of social interaction, and collaborative activities. Another interpretation of Piaget's theory stresses that the co-construction of knowledge takes place through one's increasing ability to take account of other peoples' perspectives. This ability develops through five, distinct, developmental stages; from an undifferentiated and egocentric social perspective to in-depth and societal-symbolic perspective taking (Selman, 1980; see also Häkkinen, Järvelä, & Byman, 2001; Järvelä & Häkkinen, in press a).

The second well-known mechanism for promoting learning in context of social interaction is formulated based on Vygotsky's ideas. There are two basic interpretations of Vygotsky's thought. The first, and the more traditional view, assumes that because of engagement in collaborative activities, individuals can master something they could not do before the collaboration. People gain knowledge and practice some new competencies as a result of internalisation in collaborative learning. In other words, collaboration is interpreted as a facilitator of individual cognitive development. The other interpretation of Vygotsky's ideas emphasises that learning is more as a matter of participation in a social process of knowledge construction than an individual endeavour. Knowledge emerges through the network of interactions and is distributed and mediated among those (humans and tools) interacting (Cole and Wertsch, 1996).

Influenced by Piaget and Vygotsky, a great variety of research goes under the label of CSCL covering many, even very different instructional and theoretical approaches, that aim to support individual and group learning with technology.

1.4 Past Paradigms of Studying Educational Technology

Koschmann (1996) has argued that the emergence of computer-supported collaborative learning research and development represents a Kuhnian paradigmatic shift in the history of instructional technology. According to Koschmann (1996), CSCL research is grounded on a very different concept of learning, pedagogy, research methodology, and research questions than its antecedents did. In the next paragraphs, I take a brief look at the predecessor paradigms in instructional technology.

The first instructional technology paradigm, the CAI (Computer Assisted Instruction) paradigm, manifested and reflected the ideas of behaviourism and instructional efficacy (Steinberg, 1991). The CAI programs "utilised a strategy of identifying a specific set of learning goals, decomposing these goals into a set of simpler component, task, and finally developing a sequence of activities designed to eventually lead to the achievement of the original learning objectives" (Koschmann, 1996, pp. 5-6). The idea was to build software tailored for particular learners with specific needs. Thus, CAI represented individualized computer-presented instruction (Steinberg, 1991), focused on domain specific content representations. Characteristic of the CAI programs is to pose a problem to the learner and give feedback in the course of the learning process, but with limited scope, only assessing whether the given answer was right or wrong. Often these programs are referred as drill and practice software. These packages of drill and practice software have been popular, for instance, in elementary arithmetic.

The CAI paradigm was followed by the Intelligent Tutoring Systems (ITS) Paradigm (Koschmann, 1996). Intelligent Tutoring Systems are able to interact "intelligently" with students on the basis of what students know, and in doing so, ITS promotes students' self initiated exploratory activity (Mandl & Lesgold, 1988). ITS applied methods of Artificial Intelligence research to understand skilled tutoring in complex domains. Based on information processing theory and considering cognitive processes as computational, the proponents of this paradigm were interested in instructional competence, this is, in answering the question, Could a computer program function as adaptive and skilled teacher or tutor?

Despite their differences such as, ITS representing perhaps a more interactive model of learning and aspiring to more complex skills than CAI, they share realist and absolutist epistemological assumptions, and both rely on the transmission model of instruction (Koschmann, 1996; see also De Corte, 1996). For instance, Crook (1994) places these two paradigms under a same metaphor, namely, computer as tutor and points out that both are representatives of "teaching technology, sensitive to individual learners" (1994, p. 12). Further, both CAI and ITS neglected the social and cultural conditions of learning.

The third instructional paradigm proposed by Koschmann (1996) was Logo-as-Latin paradigm. This paradigm was developed based on Piaget's ideas of cognitive development and epistemological constructivism, and, at least partly, emerged as a counterpoint for behavioristic approach. The most prominent advocate of this paradigm was Papert (1980). He stressed that students' intellectual development could be shaped significantly by engaging them in computer programming activities. By programming students could construct and discover new understanding, and learn to cultivate general problem-solving skills. These ideas were well manifested in the Turtle Logo microworld environment developed by Papert (1980). The focus of this paradigm was on instructional transfer, on asking the question, do the programming skills have effects, for instance on planning and metacognition (Crook, 1994; De Corte, 1996).

What then, constitutes the difference between the three past paradigms of instructional technology and CSCL? As stated earlier, CSCL research relies on a very different concept of learning, pedagogy, research methodology, and research questions than its predecessors did. Whilst the previous paradigms relied on pure computational and mentalist models of mind, CSCL is progressing based on socially oriented theories of cognition and learning. Whilst the antecedents of CSCL relied strongly on experimental research design, CSCL adopts a variety of methods from the fields of anthropology, communication science, and linguistic research, just to mention a few. In contrast to its predecessors that studied human cognition with experimental design and in laboratories, CSCL research in conducted also in "real world contexts", for instance, at schools. In addition, CSCL utilizes the new possibilities of networked technology, which were not, of course, available in times of the past paradigms.

Even if there is a new paradigm in instructional technology in progress, the old types of software and ideas are still popular among educators and instructional designers. Nowadays these ideas are represented, for instance, in the advanced disguise of different types of multimedia programs.

1.5 Notions about CSCL Applications

At present, the current understanding appears to be that collaboration is a synonym for good learning and good educational technology; almost any web-based application is labelled as 'collaborative.' This loose usage is also because there is no established way to classify the variety of tools that might be considered as collaborative, and moreover, because almost any technological application, could, in some way, be used in support of collaboration, i.e., by people working together on something.

Hence, it might be meaningful to make a distinction between collaborative use of technology and collaborative technology. Imagine a pair of students working at the computer running a simulation program in physics. The simulations on the screen can help the students to collaborate, by creating a referential anchor, a point of shared reference (Crook, 1994). This referential anchor can function as a "concrete" shared representation, can support the negotiation of meanings, and mediate students' communication activities in their development of reciprocal understanding (Hakkarainen, et al., 1998; Järvelä, et. al., 1999). In this case, the technology, the software developed for the individual user, is utilized in creating and establishing collaborative activities.

On the other hand, collaboration can be supported through computer networks, but not (without special efforts) those most well known on the Internet. As stated by Roschelle and Pea (1999), most of the Internet tools and discussion forums available are not robust and simple enough for use in average classrooms, or do not translate to the classroom setting. Typical Internet chat or bulletin board systems or e-mail do not organize conversations well for learning. These applications are not, in the first place, designed for pedagogical purposes of building collaborative knowledge. However, with advanced pedagogical practices, these applications can also be utilized for collaborative learning.

The most pure and original applications of CSCL and collaborative technology are, perhaps, networked learning environments (or 'groupware'; For a history of groupware, see Grudin, 1994), such as CSILE, which are designed especially for educational use and for collaborative knowledge building. A common feature of advanced network applications designed for educational purposes is that they support users' cognitive activities by providing advanced socio-cognitive scaffolding, by offering many ways to structure discussion to create collaborative representations and by including community-building tools. "These tools all scaffold learning by prestructuring the kinds of contributions learners can make, supporting meaningful relationships among those contributions, and guiding students' browsing on the basis of socio-cognitive principle" (Pea & al., 1999, p. 33).

Examples of scaffolding tools are CSILE's "Thinking types," a feature that scaffolds students' inquiry process. When students create notes, they are asked to identify the type of their note (for example, "Problem", "My theory", "I need to understand"). Another example is the CaMILE environment (Guzdial, 1997, Guzdial and Turns, 2000), which provides support in the form of distinct anchors through external Web pages, offering prompts that suggest what to write or how to start discussion. In addition, collaborative agents and other entities based on artificial intelligence are emerging. These intelligent agents may, for instance, use information from user profiles to help students working on same kind of projects to network with each other. Or they may search for and screen information that other students with the same background have found interesting and useful. Educational use of this kind of knowledge and group awareness tools probably can help manage a relatively large number of messages in databases, handle the threaded structure of discourse, and also facilitate community-building (Baek, Liebowitz, Prasad, & Granger, 1999; Häkkinen, Järvelä, & Dillenbourg, 1999; Ogata & Yano, 1998).

Moreover, one should also consider that discourse through collaborative learning environments is still mainly based on written language. In addition to writing, collaborative, representation tools, such as advanced visualization, simulation and modelling tools are needed to construct richer interchange of graphical and written representations (Roschelle & Pea, 1999). Of course, there is no necessary, intrinsic connection between computer-based collaboration and written text. The computer might store oral comments, or it might with voice recognition software, create written texts from oral remarks, so persons could 'see' what was said orally.

There are two crucial things to remember about CSCL applications. First, with respect to learning results, it is very hard to find evidence that some particular CSCL application is better than some other or better than some traditional classroom uses of computers. Secondly, as argued by Koschmann (in press) we, as developers and promoters of virtual learning environments should do a better job making explicit the theories of learning and instruction that motivate our work and that are embedded within our designs.

Technology itself does not solve the challenges of learning and collaboration. For collaborative technology can, of course, be used for other purposes than for supporting collaboration; it can easily be applied in transmitting and delivering knowledge. An important part of the use of collaborative technology is how the technology is implemented, for instance, in school setting. Among the issues for which there is still a lack of good research data are the following: Is it possible to implement CSCL without already having a deep understanding of collaborative learning and collaborative technology? Or is it possible to introduce new ideas of learning and human cognition with new technology? These are among the most important questions to respond if CSCL if going to work on a large scale.

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2. Synchronous Communication: Perspectives for Education

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The wider usage of Information and Communication Technologies (ICT) is increasing the implementation of Internet based resources at school. Even if most of the cases of collaboration between schools are developed through asynchronous communication systems, some interesting experiences of educational uses of synchronous tools have already run.

Synchronous communication is an additional resource to Computer Supported Collaborative Learning (CSCL) and to the study of how the co-construction of knowledge is developed in the collaboration processes. The educational research can benefit from the implementation of synchronous communication because it allows the study of the learning processes in the environments where they occur and while taking place. All the synchronous interactive processes mediated by technological environments are characterized by the presence of new practices from the psychosocial and discursive points of view, and by the absence of some communicational practices typical in face-to-face settings.

2.1 What kind of synchronous tools are available for education?

Most common synchronous tools are text-based chat systems, MUDs or MOOs, three-dimensional virtual environments and videoconferences. The synchronous systems differ on the basis of the communication channels that they provide for users' interaction. Each of them has of course specific communication potentialities that reside in different possible educational implementation.

Text-based chat (or Internet Relay Chat, IRC) is the most widespread synchronous tool. It allows people, who are contemporary connected to the Internet, to exchange in real time textual messages both via private and public connections.

MUD (Multi-User Dimensions) and *MOO* (Mud Object Oriented) are kinds of software program that allow multiple users (also called participants or players) to simultaneously access to a shared database and to communicate and interact mainly synchronously in a virtual environment. The environment is typically characterized by a spatial metaphor and an architectural motif; both of them are not directly visible but are only collaboratively "built" by putting into the database a textual description. The database consists of rooms, entrances and exits, and other objects, and users can manipulate and extend it. "Avatars", characters that act inside the system as simulacra of the connected people, represent the users. In the MOO the Avatar is exclusively text-based, as the entire environment. The strong text-base nature of MOOs allows the development of a narrative dimension. The virtual environment and the Avatars are created through dialogic stories, in a sort of collective "polyphony", as described by Bachtin (1981).

3-D virtual environments are new systems that integrate the text-based chat with a graphical window where a three dimensional representation of physical environments and characters is visible. The spatial organization of the interactive context is here not real but neither metaphoric anymore: space and the spatial relationships among users, virtual buildings, objects and users are represented in realistic way by three dimensional avatars. Avatars can interact with each other and with the virtual objects and can operate actively on the environment by building new structures, houses, and objects. The visualization of the results of the interaction is even a benefit for education hitherto unexplored. The use of technological supports for constructive experience of learning certainly affects the learning environment in many ways, first by shaping the information processing through particular symbolic representation forms linked to the media (Olson, 1979).

Videoconferencing desktop should be the user-friendliest synchronous tools in that it allows the use of many interactive channels and reproduce real images of the interaction in real time. Nevertheless, its implementation in educational contexts is not really successful. When examining this kind of tool from a practical point of view it is clear that it should take some advantage to the interaction as it allows the most "natural" way of interacting. Some recent experiences that implemented videoconference in educational contexts show that the success of its usage is mostly connected to the quality of the planning of the full learning environment in which the videoconference is inserted more than on the contingent interactive situation itself (Talamo and Zucchermaglio, 2000).

2.2 Synchronous communication as a resource for learning contexts

When compared to other systems of mediated communication, synchronous systems add specific resources to CSCL:

- *Telepresence perception*: As Riva and Galimberti (1998) notice, the physical co-presence of persons was traditionally used in order to distinguish the concept of "interaction" from the "relationship", where the latter was possible even at a distance. In CMC, the interactive activities are also possible at a distance in that CMC systems allow the coordinated activities of more users on the same objects. Most synchronous tools allow specific types of interaction where most of the physical cues, normally present in face-to-face situations, are not available. For this reason, CMC tools are considered to offer "rarefied" forms of interaction. Nevertheless, some features of synchronous tools sustain the basic characteristics of interaction that can allow the perception of a sort of "telepresence". First, the possibility of having synchronous feedback, secondly, the possible "co-formulation" of the utterances (Riva and Galimberti, 1998; Mantovani, 1996).

- *Direct and "immediate" interaction among users*: in comparison with the asynchronous communication, the advantage of online interactions is that it is possible for users to monitor and regulate the participation in the collaborative process according to the interactive context and situation.

- *Dynamic and fluid management of learning process*: synchronous communication allows the implementation of new kinds of tutorship as it sustains a situated and dynamic guidance of students that would not be possible in asynchronous systems. Recent research (Ligorio, Talamo, and Simons, submitted) shows that new ways of collaborating, also by sharing the management of the learning process, depends on the creation of synchronous on-line communities of learners.

- *New technological resources for interacting:* many synchronous systems offer users some resources that can be used during the interactive exchange, e.g., the possibility of playing with unreal identities (using nicknames or personifying avatars), or using virtual objects. Recent studies (Talamo, Zucchermaglio and Ligorio, in press; Ligorio and Talamo, submitted) show that these features are strategically used by participants as interacting resources in the negotiation processes during knowledge co-construction. Creating an identity, not only as a learner, is one of the bases for learning (Nichani, 2000). As Wenger (1998) states, "because learning transforms who we are and what we can do, it is an experience of identity" (p. 215).

- *Different metaphors for learning contexts*: some of the text- based chat systems (i.e. MOO and MUD) and the 3-Dimensional virtual worlds foster a spatial representation of the learning context where the active building is evident and explicitly encouraged. In some asynchronous systems, the use of space is representative of semantic connections and concept mapping (like in navigating most of the websites on the Internet). On the contrary, the use of space in synchronous environments is mostly intended as a dynamic representation of knowledge building. Recent studies show that the spatial metaphor does not fit the representation of what hypermedia is in terms of information organization, but gives only a key for navigating through the information according to the producers' expectations and intentions (see also Boechler, 2001; Talamo and Fasulo, in press). In synchronous systems, the space itself is a product of the interaction among users, and it is the virtual representation of the evolution of the learning process. This is consistent with the constructivist theory of learning.

- *New shared repertoires* are co-constructed via synchronous communication. The sharing of a common repertoire among learners and all other actors in the learning environment is one of the basic features of the development of a community (Wenger, 1998). As the interaction is more dialogical, dynamic, there is synchronicity in "talking and listening" to each other; the negotiation of shared meanings is more fluid.

2.3 Advantages of synchronous communication for CSCL

What is called the "third generation distance education" (Kaye, 1994) contributes to the support of computer assisted education, offering the tools for introducing students to a real communication network which put classroom work in a wider context of interaction. The relevance of introducing technological resources in the school for the enhancement of communication practices lies in the possibility to use communication systems (e.g. e-mail, videoconferencing, chat) and sharing systems (electronic blackboard, systems for the exchanging of files) either as synchronous or asynchronous tools.

When can synchronous communication be recommended suitable for education? Based on the existing experiences, it is possible to single out a few cases when the synchronicity seems to offer considerable advantages to groups working at a distance.

- *To acquire information about the local context*. The climate of the context where users are working in real life is hard to describe. By meeting the partners on-line, it is *possible* to get a better feeling about what type of situation and what type of climate they are involved in. When local contexts are described asynchronously, the information is selected along criteria not always visible. When information is given on-line, it is natural to give also information not essentially task-oriented, but important to give an idea of who the users are and how is the real context in which they are embedded.

- *To make decisions and to express social consensus.* Certain decisions are not easily made, especially when there is no centralized organization. When participants have to make collective decisions, for instance, about specific responsibilities, the on-line discussion helps the process of decision-making. Decisions made during on-line discussions are easily shared and acknowledged by all the participants. Comments and remarks are situated at the time of the discussion and the decision making process is not slowed down. During on-line chats, it is also easy to require all the participants to express their opinion, and social consensus can be reached.

- *To facilitate information analysis.* If asynchronous communication facilitates a reflective process, it may happen that information is acquired but the reflective thinking about it is not shared. By organizing an on-line group-discussion about the information available, it is possible to reinforce the process of sharing insights and thoughts. In this way, participants are able to express their point of view and they can move toward a more central participation.

- *To clarify ambiguities generated through other communication tools.* Sometimes some of the functionalities of technological solutions can create ambiguous situation under a communicative point of view. One of the most common problems of asynchronic communication, such as the discussion forum or mailing list, is that often messages do not get a reply because is not clear who is in charge of the answer. Synchronous communication offers a more dialogical experience that allows often the overcoming of this kind of misunderstanding.

2.4 Difficulties of synchronous communication:

Coordination in time. The main problem for schools in organizing chats on-line is to set an agenda where more classrooms can be connected at the same time. The classroom's agenda is often not flexible enough to allow teachers to choose when to connect. Thus, it is hard to have two or more classrooms connected to each other at an established time. At the moment, the only way to solve this problem is to account on the availability of the colleagues and of the computers located in schools.

Tutoring and monitoring of the multi-user dimension. Chats have usually a very fast tempo; the objective of the session may stay in the background and new conversation topics – more or less correlated to the official one – are generated. This means that more topics are carried out contemporaneously and they are all interviewed. In order to manage this problem it is necessary, first, to restrict the number of participants connected at the same time. Secondly, it is necessary to have tutoring that guarantees coherence with the objectives of the session, although it is necessary to have certain flexibility in leaving discussion spaces for on-line generated issues.

Acquisition of interacting competences. Being able to chat is not obvious for everybody. The nature of the chat – fast, interviewing different sub-topics, multi-users, and the use of abbreviations and *emotes* – requires certain competencies. Those competences are mainly acquired directly on-line. It is not possible to explain how to chat: this can be learnt *by doing,* by directly doing it. Also in this case it is important to tutor the students in acquiring this competence by an opportune tutorship that could include the use of the *whisper* – the private chat – and the reading of the recorded chats. Even interacting via videoconference is not natural as the turn taking and some basic rules for interacting in an effective way should be learnt.

2.5 The advantages of combining synchronous with asynchronous communication

Having rich and flexible educational environments is considered a great opportunity for knowledge building and collaborative learning. Computer based environments tend to be designed to include different tools and support several types of communication and collaboration. The integration and combination of different tools within the same technological environment provide mutual enrichment. Both synchronous and asynchronous communication has specific features and by combining them, certain educational activities can have a higher impact (Ligorio, in press).

- *Interim evaluation*. Theoretical innovation introduced by the collaborative learning approach implies changes in the evaluation processes. First, learning should be evaluated not only at its final stage but also while occurring. Secondly, evaluation should include student voice. The combination of synchronic and a-synchronic communication can create occasions to evaluate the learning process in the interim and so that students can reflect upon their activities by discussing them, with and within the community.

- *To support the collaboration at a distance.* Collaboration at a distance is not an easy process and it is articulated through different phases. Combining, for example, chats and discussion forum, the two mechanisms recognized as promoting collaboration (conflict management and social interaction; see also Lipponen in this report) can be fully exploited. For instance, having available both synchronous and asynchronous communication tools, the transfer from the classroom to the virtual environment and vice versa is facilitated. In this way, more points of view are expressed and the discussions are based on the information as well as on the emotional dimension.

- *To enrich the knowledge building.* The synchronous dimension allowing participants to discuss information and ideas on-line enriches knowledge building. Asynchronous communication represents a “place” where requests, ideas, and discussions can be stored in a more permanent manner and, thereby, having the possibility for re-reading and reflecting on what has been written. At the same time, the synchronous dimension can solve ambiguities, can fulfil the need for immediate replies, and can give a personalized version of what each participant thinks or says.

Synchronous communication is then a relevant resource for educators in order to evaluate the quality of the learning experience other than taking into account only the end product.

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3. Overview of the Recent CSCL Research in Europe

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This chapter provides an overview of the current situation of the uses of ICT in collaborative learning in Europe. The overview is based on the First European Conference on Computer Supported Collaborative Learning (Euro-CSCL), held at the University of Maastricht, the Netherlands on March 22-24, 2001. This conference is a continuation to three earlier international conferences on this topic held in the US and Canada between 1995 and 2000, and it is devoted to the exploration of technology in collaborative forms of learning, teaching, and working. The CSCL conferences aim at exchanging ideas and expertise in order to explore how new technology can be implemented in education in fruitful ways.

As a platform for international exchange of current ideas in the research of CSCL, the Euro-CSCL conference thus provides an excellent window to the latest developments of innovative collaborative learning technology in Europe. The first European CSCL Conference focused in particular in European research initiatives and the development of a European CSCL community. Various domains of knowledge, such as education, psychology, computer science, anthropology, sociology, communication, linguistics, and ergonomics are involved in studies presented in this conference. Many researchers, software designers, and educators participated in the conference.

Based on approximately 60 presentations of the Euro-CSCL conference by European researchers or research institutes[1], this chapter addresses the following issues: the theoretical foundations of and the pedagogical practices with CSCL as well as the current research on and the current challenges of CSCL.

3.1 Theoretical foundations and pedagogical practices of CSCL

The acronym CSCL does not, as the editors of the conference proceedings point out in their introduction, “by itself, provide a clear description of the research area. Both the instructional settings as well as the technologies are changing so rapidly, that it is difficult to say much about the definition that is not, or will not in the near future, become subject to contradiction." The presentations of the First European Conference on CSCL reveal the great diversity of views on CSCL and of the pedagogical practices it includes.

The articles of this conference build on different kinds of theoretical approaches. Some studies build explicitly on some specified theoretical approach, such as activity theory (e.g. Bourguin & Derycke; Fjuk et al; Docq & Daele; Issroff & Scanlon; Verdejo et al.), distributed cognition (e.g. Stoyanova & Kommers), knowledge building (e.g. Muukkonen et al.; Rahikainen et al.). However, the lack of explicitly defined pedagogical theory of computer supported collaborative learning is obvious in many studies presented in this conference. Many articles are either not explicitly anchored in any pedagogical theory or only in some kind of loose constructivist framework.

Within these pedagogical frameworks, there is a variety of pedagogical models or approaches employed in the different projects. These include problem-based learning (Fahraeus; George & Leroux; Koch et al.; Tosunoglu et al.), reciprocal learning (e.g. Anderson et al.), cognitive apprenticeship (e.g. Karlgren; Tholander) and progressive inquiry (e.g. Muukkonen et al.; Lakkala et al.; Rahikainen et al.).

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[1] A full list of the presentations reviewed for this chapter is before the References section. See also http://www.mmi.unimaas.nl/euro-cscl/presentations.htm.

The educational settings and contexts in which educational technology is used vary from constant physical presence of the co-learners to distance learning situations where there is no face-to-face contact between the learners. Most projects include some face-to-face collaboration but the degree and role of computer-supported collaboration over distance varies. Loosely, the different pedagogical projects presented in the conference can be categorized as follows.

First, there are projects in which the collaboration between the learners takes place face-to-face only, i.e. pairs or groups of learners working collaboratively on some task at one computer. An example of such a project is a project presented by Abnett et al.

Secondly, there are projects in which face-to-face collaboration is combined with collaboration that takes place in a network-based learning environment within the classroom. In the reviewed articles, this is the most common type of CSCL in school settings. They often include a network based knowledge-building environment of some kind (e.g. CSILE).

Third, there are projects in which pairs or groups of learners in one classroom collaborate with each other face-to-face while collaborating with pairs or groups of learners in another school over the web. For example, in the Greek project presented by Kynigos, Dimaraki & Trouki, students from three different classes from different parts of Greece collaborated in a joint project in mathematics and geography with the aim of planning an exchange of pupil visits.

Fourth, there are projects in which most collaboration takes place in a network-based learning environment over distance while there is also some face-to-face collaboration. These projects are quite common in higher education settings. In addition to some face-to-face meetings, the network based learning environments are employed extensively by individual students in order to scaffold the process of collaborative knowledge building on some complex problem (e.g. Lahti et al.).

Fifth, there are projects which employ computer supported collaborative learning in distance learning settings with no or very little face-to-face contact. In these projects, students collaborate only through technology, through a network based learning environment or through audio or video-conferencing or both (e.g. Arnseth et al.; Joiner et al.; Ligorio et al).

3.2 Research on CSCL

There are numerous projects in Europe in which ICT is implemented in learning and instruction, both in primary, secondary, and higher education. However, as one of the authors has discussed elsewhere (Pyysalo, Kruppa, & Mandl, 2001), intensive research cooperation between schools and research institutes is still not very common in Europe. Most research-based and scientifically evaluated projects are found in the level of higher education. The review of the presentations of the First European CSCL conference consolidates this observation. Only one in five presentations focused on school context (primary and secondary education) while about half of them focused on higher education.[2] In this chapter, both school-based and university-based research projects will be discussed.

The presentations reviewed show the variety of aspects of computer supported collaborative learning that is currently being studied in Europe. The aspect most commonly addressed was technical design principles and their educational implications. Another focus of research that features in a great number of presentation seems to be the nature of processes of communication, collaborative inquiry and knowledge building in network based environments (since at least four in five presentations dealt with these issues, the names of the authors are not listed here). Further, issues addressed in some presentations include aspect of

[2] The rest of the presentations were based on the development of technology that was meant to support learning in various contexts. Some of these were also experimental studies, which did not focus on any particular organizational context or focused on learning in vocational education or at work.

motivation, engagement and participation in computer supported collaborative learning (e.g. Cullen; Lipponen et al.; Takala et al.) as well as the role of the teacher or tutor (Lakkala et al.; Rahikainen et al.; Veerman et al.). A few studies also focused on the evaluation and further development of pedagogical models for computer supported collaborative learning (e.g. Anderson et al.; Karlgren; Muukkonen et al.; Lakkala et al.; Rahikainen et al.; Tholander). Very few presentations focused on the theoretical foundations of computer supported collaborative learning (see Strijbos & Martens; Issroff & Scanlon).

3.3 Possibilities and challenges of CSCL

The presentations of the Euro-CSCL 2001 conference show the variety of ways in which technology can support collaborative learning in educational settings. Collaborative technologies are shown to enhance student motivation, self-reflection, working with complex problems, and promote collaboration between learners. However, the studies presented also bring up many challenges that an effective implementation of CSCL faces.

Research on computer supported collaborative learning being as multifaceted as it is in its theoretical foundations and methodological approaches, and also given the technology-driven character of many research projects in this field, one of the central challenges of research on CSCL in Europe will be the developing of pedagogical models and methodological approaches. While several authors acknowledged the need for new methodological approaches, only few presentations handled this issue.

Many further challenges arise when considering the implications of CSCL research for educational practice. Bringing research into practice is, as Eurelings pointed out in her keynote presentation of the Euro-CSCL conference, a wilful issue which "seems to fit in the category of 'wicked problems'", wicked problem being defined as a "problem that can be characterized as an evolving set of interlocking issues and constraints in a constantly changing context". The presentations of the CSCL conference draw a picture of this wicked problem, providing a good overview of the versatile challenges that face the implementation of computer supported collaborative learning in authentic educational contexts.

One central factor influencing the realization of computer supported collaborative learning in authentic educational settings seems to be the school culture. School culture poses great challenges on the effective implementation of CSCL practices on many levels. On organizational level, challenges include issues concerning the compatibility of CSCL with the curriculum and the organizational structure of the school (e.g. Cullen). Achieving changes on this level is often out of reach of individual teachers or researchers.

While tackling the organizational problems is very important, the presentations reviewed show quite clearly that it is not enough. There are, also, strong cultural constraints on the level of teachers and, indeed, the learners themselves. Teachers and students have usually developed an implicit understanding of what schooling and learning are all about. The studies presented in this conference show how these pre-conceptions of the teachers and learners can hinder the full realization of the potentials of computer supported collaborative learning. Many learners seem to have great difficulties in participating in collaborative inquiry activities if these are not highly structured and if they are not given clear instructions (e.g. Blake & Rapanotti; Ploetzner et al.). Further, the presentations revealed that learners often do not reach a higher level of discussion and knowledge building (e.g. Lipponen et al.; Muukkonen et al.; Mäkitalo et al.). Students' pre-conceptions are also shown to affect the learning process (e.g. Tholander). For example, many learners seem to operate under the assumption that a knowledge building process in school environment is a kind of a "question-answer-game" (see Kynigos, Dimaraki & Trouki), in which they do not need to give further information to continue the discussion if they have not been explicitly asked for it. In addition, teachers were shown to have difficulties in guiding a collaborative inquiry process (e.g. Rahikainen et al.).

There are also several pedagogical challenges brought up in the presentations of the conference. We do not yet seem to fully understand how technology should be employed in order to best support collaborative learning and higher-level knowledge building in different educational settings. Furthermore, many researchers have acknowledged a need for deeper knowledge about the kinds of activities that should accompany CSCL. Some studies revealed that in order to achieve best results, CSCL should not be understood as a *replacement* of traditional, more individualistic instructional approaches but rather, we should seek for an understanding of the best *combination* of the two (e.g. Muukkonen et al.). In addition, one great challenge on the pedagogical level is the observed unequal participation of the learners in computer supported collaborative learning. Some studies pointed out a tendencial exclusion of weaker or less motivated learners from computer-mediated discussions (e.g. Cullen, Lipponen et al.; Rahikainen et al.; Tapola et al.). The presentations also bring up the challenge of better understanding the kind of pedagogical support needed during computer supported collaborative learning (e.g. Salovaara & Järvelä; Tholander). The new pedagogical models should take these issues into account.

In order to answer both the cultural and pedagogical challenges, it seems that we also need to explore further the nature of computer supported communication and inquiry itself. The presentations show that many researchers have already taken up this challenge. As the editors of the proceedings observe in their introduction, there has been a change in the research on CSCL to more detailed research on the characteristics of discourse and argumentation. Accompanying this process, there is also a need to develop new ways of assessing the learning outcomes in computer supported collaborative learning, because the traditional assessment methods are not necessarily able to show the benefits gained through this kind of learning (e.g. Karlgren).

We need, of course, innovations in order to turn the new pedagogical understandings into effective use of educational technology. However, a problem of adequate technical resources is still a major issue in European education. Many schools in Europe still struggle with basic problems of technical infrastructure (the availability of and access to technological resources) as well as shortage of IT-trained staff (e.g. Berger et al.; Cullen).

3.4 Closing remark

As Eurelings further pointed out in her keynote speech of the conference, we need to explore what aspects are vital for success in implementing computer supported collaborative learning in educational settings, and also learn from the earlier experiences. The aim of this overview of the presentations in Euro-CSCL 2001 conference has been exactly this: to summarize the experiences gained so far in European research on CSCL and, for its part, provide a basis for the discussion about and further exploration of the aspects vital for success in developing collaborative learning technology and implementing it in European education. It doing this, it hopes to promote a better transfer from research to the innovation process within existing educational practice.

Reviewed presentations written by European researchers from the Proceedings of the Euro-CSCL 2001 conference:

Abnett, C., Stanton, D., Neale, H. & O'Malley, C.: The effect of multiple input devices on collaboration and gender issues.

Allison, C., McKechan, D., Ruddle, A.: A group based system for group based learning.

Andersson, S., Brodin, E., Hindbeck, H., Höög, J., Langerth-Zettermann, M. & Strömdahl, H.: Reciprocal, evaluation-based collaborative teaching and learning in the information intense, dynamic and cross disciplinary environment of Bioinformatics. (The article is found only in http://www.mmi.unimaas.nl/euro-cscl/presentations.htm)

Armitt, G., Green, S., Beer, M.: Building a European Internet School: developing the OTIS Learning Environment.

Arnseth, H. C., Ludvigsen, S., Wasson, B. & Mørch, A.: Collaboration and problem solving in distributed collaborative learning.

Ashdown, M. & Robinson, P.: The writing's on the wall: Large, remotely controlled displays.

Baker, M., de Vries, E., Lund, K., Quignard, M.: Computer-mediated epistemic interactions for co-constructing scientific notions: Lessons learned from a 5-year research programme.

A. Berger, R. Moretti, P. Chastonay, P. illenbourg, A. Bchir, R. Baddoura, P. Farah, C. Bengondo, P. Ndumbe & B. Kayers: Teaching community health by exploiting international socio-cultural and economical differences.

Boticario, J., Gaudioso, E. & Catalina, C.: Towards personalised learning communities on the web.

Bourguin, G. & Derycke, A.: Integrating the CSCL activities into virtual campuses: Foundations of a new infrastructure for distributed collective activities.

van Boxtel & C., Veerman, A.: Diagram-mediated collaborative learning: Diagrams as tools to provoke and support elaboration and argumentation.

Buckingham Shum, S., Marshall, S., Brier, J., Evans, T.: The Lyceum Internet Voice Groupware System: technical design, implementation & deployment of distance learning.

Collins, T., Mulholland, P. & Watt, S.: Using genre to support active participation in learning communities.

Cossentino, M. & Lo Faso, U.: Workgroup Hypermedia Editor: A tool to support a strategy for cooperative hypermedia production.

Cullen, J.: Start-Trek meets Slackers: The impact of collaborative learning systems on school performance. (The article is found only in http://www.mmi.unimaas.nl/euro-cscl/presentations.htm)

Docq, F. & Daele, A.: Uses of ICT tools for CSCL : How do students make as their own the designed environment?

Erkens, G., Jaspers, J., Tabachneck-Schijf, H. & Prangsma, M.: Computer-supported collaboration in argumentative writing.

Fahraeus, E.: Collaborative learning through Forum Systems - Problems and Opportunities.

Falquet, G., Hurni, J., Guyot, J. & Nerima, L.: Learning by creating multipoint of view scientific hyperbooks.

Fischer, F. & Mandl, H.: Facilitating the construction of shared knowledge with graphical representation tools in face-to-face and computer-mediated scenarios.

Fjuk, A. & Ludvigsen, S.: The complexity of distributed collaborative learning: Unit of analysis.

Fjuk, A. & Smørdal, O.: Networked computers' incorporated role in collaborative learning.

Garcia Lopez, P., Rallo Molla, R., Gisbert, M. & Gómez Skarmeta, A.: ANTS: A new collaborative learning framework.

Gaßner, K.: Architecture of a cooperative discussion environment based on visual languages.

George, S., Leroux, P.: Project-based learning as a basis for a CSCL environment: An example in educational robotics.

Haber, C.: Modeling multiuser interactions.

Häkkinen, P., Järvelä, S. & Byman, A.: Sharing and making perspectives in web-based conferencing.

Hermann, F., Rumel, N. & Spada, H.: Solving the case together: The challenge of net-based interdisciplinary collaboration.

Hurme, T. & Järvelä, S.: Metacognitive processes in problem solving with CSCL in mathematics.

Issroff, K. & Scanlon, E.: Case studies revisited: what can activity theory offer.

Jermann, P., Soller, A. & Muehlenbrock, M.: From Mirroring to Guiding: A Review of State of the Art Technology for Supporting Collaborative Learning.

Joiner, R., Scanlon, E., O'Shea, T. & Smith, R. B.: Technological mediation for supporting synchronous collaboration in science and statistics.

Karlgren, K.: Talk Tracks - Learning from experienced practitioners deliberating on their problems.

Koch, J., Schlichter, J. & Tröndle, P.: Munics: Modeling the flow of information in organizations.

Kynigos, C. & Giannoutsou, N.: Seven year olds collaborating to construct a map using G.P.S. and space representation software.

Kynigos, C., Dimaraki, E. & Trouki, E.: Communication norms challenged in a joint project between two classrooms.

Lahti, H., Seitamaa-Hakkarainen, P. & Hakkarainen, K.: The nature of collaboration in computer supported designing.

Lakkala, M., Muukkonen, H., Ilomäki, L., Lallimo, J., Niemivirta, M. & Hakkarainen K.: Approaches for analysing tutor's role in a networked inquiry discourse.

Lally, V.: Analysing teaching and learning interactions in a networked collaborative learning environment: issues and work in progress.

Ligorio, B., Mininni, G. & Traum, D.: Interlocution scenarios for problem solving in an educational mud environment.

Lipponen, L., Rahikainen, M., Lallimo, J. & Hakkarainen, K.: Analyzing patterns of participation and discourse in elementary students' online science discussion.

Löhner, S. & van Joolingen, W. Representations for model construction in collaborative inquiry environments

Mäkitalo, K., Salo, P., Häkkinen, P., Järvelä, S.: Analysing the mechanism of common ground in collaborative web-based interaction.

Muukkonen, H., Lakkala, M. & Hakkarainen, K.: Characteristics of university students' inquiry in individual and computer-supported collaborative study process.

Mwanza, D.: Changing tools, changing attitudes: Effects of introducing a CSCL system to promote learning at work.

Ploetzner, R., Diehl, M., Hesse, F. & Reimann, P.: The Virtual Graduate College "Knowledge acquisition and knowledge exchange with new media".

Rachada Monthienvichienchai, P., Sasse, A. & Wheeldon, R.: Educational metadata: Teacher's friend or foe?

Rahikainen, M., Lallimo, J. & Hakkarainen, K.: Progressive inquiry in CSILE environment: teacher guidance and students engagement.

Salovaara, H. & Järvelä, S.: CSCL in secondary school literature class - focus on students' strategic actions.

Schwarz, B., Neuman, Y., Gil, J., Ilya, M.: Effects of argumentative activities on collective and individual arguments.

Sikkel, K., Gommer, L. & van der Veen, J.: A cross-case comparison of BSCW in different educational settings.

Stoyanova, N. & Kommers, P.: Learning effectiveness of concept mapping in a computer supported collaborative problem solving design.

Strijbos, J. & Martens, R.: Group-based learning: Dynamic interaction in groups.

Tapola, A., Hakkarainen, K., Syri, J., Lipponen, L., Palonen, T. & Niemivirta, M.: Motivation and participation in inquiry learning within a networked learning environment.

Tewissen, F., Lingnau, A., Hoppe, U., Mannhaupt, G. & Nischk, D.: Collaborative writing in a computer-integrated classroom for early learning.

Tholander, J.: Students interacting with and through a cognitive apprenticeship learning environment.

Tosunoglu Blake, C. & Rapanotti, L.: Mapping interactions in a computer conferencing environment.

Ulicsak, M., Daniels, H. & Sharples, M.: CSCL in the classroom: The promotion of self-reflection in group work for 9-10 year olds.

Veerman, A. & Veldhuis-Diermanse, E.: Collaborative learning through computer-mediated communication in academic education

Verdejo, M.F., Barros, B. & Rodríguez-Artacho, R.: A proposal to support the design of experimental learning activities.

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4. Implementation of Progressive Inquiry in Finnish CSCL-settings

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4.1 ICT in Finnish education

This description is based on the broader review of ICT in Finnish education in Lehtinen, Sinko, & Hakkarainen (in press). Further information is also in Hakkarainen et al. (1998) and Sinko & Lehtinen (1999).

The challenges of the information society and globalisation continue to grow. Dramatic breakthroughs in the creation of networks and communication technology in the 1990s have begun to alter the educational scene. For example, there have been genuine attempts to break out of the confines of traditional educational institutions and orient teaching around expert cultures, thus enabling students to become acquainted with expert networks. Signs of these changes have been found in Finland, as well. This convergence of education and the "real world" coincides with two related developments: 1) the revolution of ICT; and 2) profound paradigm shifts in our concepts of learning. These developments are being harnessed and guided by national educational ICT strategies and policies.

Practically all students in Finland have access to ICT. The latest national survey results show that 74% of male and 68% of female students have a computer available at home. In Finland, a family's educational and financial status also affects its information technology purchases. In a 1996-97 survey by Statistics Finland on the use of ICT in households, a correlation was found between the income level of a family and its purchase of home computers. Although there was a correlation between income level and computer purchases in the whole population, this correlation is not as clear in families with children. Indeed, Finnish families with children seem to consider the purchase of a computer as extremely important, and consequently even lower-income families have bought them, rather as they used to buy large encyclopaedia sets to help their children in school. Families gave similar motives for buying a computer, saying that the children wanted them or that they were buying them for the good of the children. Neither the formal nor the informal educational systems have managed to solve great variations in the equality of access or of the actual use of computers.

Although all schools have computers, there are still big differences in ICT resources at different types and levels of educational institutions. In the academic year 1997-98, Finnish primary schools had one computer per 6-12 students and secondary schools one computer per 8-16 students. In universities, we found great variation between the different faculties. At worst, there were 50 students per computer, and at best about 5. The average was a little over 14 students per computer, which is roughly the same figure as in lower and upper secondary schools. In polytechnics, the relative number of computers at the disposal of students was clearly higher, with only a little over 3 students per computer. Practically all schools and educational institutions in Finland are connected to the Internet. The fact that universities fare less well than institutes of vocational higher education is at least partially explained by the fact that the highest priority in universities has been to arrange high-quality computers for the research and teaching staff.

The data describing students' access to technology at home and in school still indicate a clear gender difference. Boys more frequently have a computer and Internet connection available at home. There are also more computers for students in those departments in vocational schools and higher education that are more popular among male students.

How computers are used in education depends on the pedagogical competence and technical skills of the teaching staff who must know how to exploit these modern technologies in pedagogically meaningful ways. Teachers themselves report huge differences in their capacity to utilise these technologies. A self-report questionnaire was administered to 608 Finnish elementary and high school teachers representing 64.1% of the intended teacher population. The study indicated that only a small percentage of teachers had adequate technical ICT skills, although a majority of them had access to a computer either in their home or at school. The study furnished evidence that teachers who actively use ICT emphasize the importance of using information technology for supporting research-like processes of inquiry, collaborative learning, and the learners' active engagement in knowledge-formation process more than other teachers. Further, the results indicated that the discrepancy between teachers' pedagogical principles, that commonly emphasizing active construction of knowledge, and their actual pedagogical practices, was lower among teachers who intensively use the ICT than other teachers. Apparently, they had adequate means for pursuing new pedagogical practices. In addition, it was revealed that female teachers do not have as strong skills in ICT as male teachers. These female teachers appeared, however, to be willing to deepen their expertise in ICT and to develop and explore new pedagogical practices.

The majority of teachers in the Finnish assessment study felt that their own technical skills were not good enough for effective use of ICT in their education. Even more frequently, teachers expressed the sentiment that they lacked the sufficient pedagogical expertise to use ICT as a tool in their teaching. They also claimed that there was not enough technical support at their disposal when they tried to apply ICT in their teaching. Therefore, in order to achieve lasting results, both the owner of the school as well as all parties involved in the project must commit themselves to it. Sufficient outside expert support must be secured as well.

It is also obvious that the pedagogical ideas used in small-scale experiments are not familiar to the regular teachers or are not easy to adopt by them. For example, in an assessment study, Finnish teachers did not regard collaborative learning as an important application of computers although the scientific community has considered the principles of computer supported collaborative learning to be highly promising for the development of future learning environments (Hakkarainen et al., 2001).

4.2 Theoretical principles and models for CSCL in Finland

In this section, we will present progressive inquiry as a synthesis of different approaches of learning and as a model of pedagogical implementation in the context of CSCL. The model is in the background of best practices in CSCL in Finland, but it is a general pedagogical and epistemological framework, which can be applied in a variety of ways, and the elements can be emphasized differently in different countries and settings. Progressive inquiry model is also embedded in the CSCL software that will be developed in the ITCOLE project.

4.2.1 Facilitating Scientific Inquiry in Education

One of the basic requirements for future education is to prepare learners for participation in a knowledge society in which knowledge is the most critical resource for social and economic development. Knowledge work is characterized by systematic knowledge advancement, and students are expected to engage in deliberate knowledge creation in the future society. In order to facilitate this kind of development it is important that students learn to work with knowledge in the same transformative way that experts are doing. It follows that they should not only be engaged in exploitation of knowledge in their studies but also practice skills of knowledge creation. These kind of skills should be taught throughout the educational system by increasing research-like aspects in all teaching and involving in-depth research courses in all levels of education.

A principal requirement is to be able to work productively with knowledge. These involve skills of independently searching, producing, and managing knowledge. Developing various kinds of ideas in the context of practical or principal problem solving and explicating these ideas so that those could be further developed and shared with the other inquirers. James March makes a distinction between explorative and exploitative actions in organizational practices. Exploration means such activities as search, discovery, novelty, and innovation. This definition includes risk taking and experimentation with which the very important new direction is occasionally reached. By exploitation is meant refinement, routinisation, production, and implementation of knowledge. One may argue that educational system has almost exclusively been dealing with exploitation of existing knowledge. Finding pre-existing answers to well-defined questions does not provide the students good qualifications for finding a productive balance between exploitation and exploration.

Several researchers have proposed that in order to facilitate higher-level processes of inquiry in education, cultures of schooling should more closely correspond to cultures of scientific inquiry (Brown, Collins, & Duguid; 1989; Brown & Campione, 1994; 1996; Carey & Smith, 1995; Perkins, Crismond, Simmons, & Unger, 1995; Scardamalia & Bereiter, 1994). In order to get an idea how scientific inquiry is actually pursued, the students should systematically participate in processes in which they have to apply scientific methodology, such as generating research questions, solving complex problems, constructing hypotheses, building theories, and designing experiments. Experiences of the actual doing of science would help students to deepen their conceptual understanding and learn scientific thinking, not just assimilate scientific knowledge as a finished product of the process.

Scardamalia and Bereiter (1991; 1992; 1994) proposed that scientific thinking could be facilitated in school by organizing a classroom to function like a scientific research community and guiding students to participate in practices of progressive scientific discourse. Thus, schools should be restructured as knowledge-building communities through facilitating the same types of social processes, such as a collaborative effort to advance knowledge, that characterize progressive research teams and laboratories. Characteristically scientific communities work to produce knowledge, take the ideas created as an object of inquiry, and collectively pursue advancement of the knowledge constructed.

Scardamalia and Bereiter (1994) have, further, argued that there are no compelling reasons why school education should not have the dynamic character of scientific inquiry. The analogy between school learning and scientific inquiry is based on a close connection between processes of learning and discovery. Inquiry pursued for producing new knowledge, and inquiry carried out by learners working for understanding new knowledge is based on the same kinds of cognitive processes. Learning, analogously with scientific discovery and theory formation, is a process of working toward more thorough and complete understanding. Although students are learning already existing knowledge, they may be engaged in the same kind of extended processes of problem solving and productive working with knowledge as scientists and scholars.

From a cognitive point of view, scientific inquiry can be characterized as a question-driven process of understanding. Without a research question there cannot be a genuine process of inquiry although information is frequently produced at school without any guiding questions.

In the 1970s, Jaakko Hintikka initiated Interrogative Model of Inquiry (I-Model), which was developed by him and his co-workers into a full-blown view: scientific inquiry and knowledge acquisition generally are viewed as a question-answer process. Although the interrogative process can be formalized by using the logic of questions (see Hintikka, 1988), here we view the model more informally as a conceptual tool for analysing question-driven process of inquiry. The model has been applied to a range of topics from explanation and discovery to history of science, such as Darwin's theory of evolution (see Sintonen, 1990b, 1991).

The interrogative model of inquiry conceptualises a dynamic process of inquiry through which new knowledge and understanding emerges by separating two types – and levels – of questions (Hintikka, 1985; Sintonen, 1984). On one hand, there is an initial principal or big question, which is determined by the cognitive goals of inquiry. On the other hand, there are small subordinate questions to which answers are needed in order to approach the principal question. Principal questions are often explanation-seeking in nature and arise when an agent tries to fit new phenomena to his or her already existing knowledge. The two levels of questions differentiated by the model are a dynamic feature that fosters acquisition of new information during the process of inquiry (Sintonen, 1993). The agent tries to solve the big question through using his or her existing knowledge and new information that provide answers to a series of subordinate questions. Examining a chain of questions generated can capture advancement of inquiry. By finding answers to subordinate questions, an agent approaches gradually toward answering the big initial question, and thus changes his or her epistemic situation. Several cognitive researchers (Ram, 1991; Scardamalia & Bereiter, 1992; Simon, 1977) has pointed out that in a successful process of inquiry new questions are generated from original questions.

From a historical perspective, the interrogative view is perhaps the first explicit view of how knowledge is acquired and how it can be transmitted in both science and in everyday life. For example, Socratic dialogues were based on the assumption that questioning is the method of bringing forth knowledge, and Aristotle's four types of causes are best viewed as answers to four distinct types of explanation-seeking why-questions (Moravcsik, 1974; Sintonen, 1989). From the pedagogic perspective, the interrogative view has the advantage that it specifically connects scientific inquiry with knowledge seeking generally. Scientific research differs from ordinary thinking in that it is geared to exploring the consequences of highly structured and hierarchically layered conceptual networks, but the difference is one of degree rather than of principle. Questions and answers are the currency of our daily speech acts and deeply entrenched in our cognitive capacity. Nevertheless, the same is true of scientific inquiry: all research projects can be cast in the form of one or more initial questions and a request to make these questions more precise and answerable through observations and experiments.

4.2.2 Elements of Progressive Inquiry in CSCL

By synthesizing the ideas of cognitive research and interrogative model, we expand and elaborate a framework for *progressive inquiry*. This framework is especially developed for pedagogical purposes. It is a general model for conducting scientific inquiry in schools.

Put brief, progressive inquiry is a sustained process of advancing and building of knowledge characteristic of scientific inquiry. It entails that new knowledge is not simply assimilated but constructed through solving problems of understanding. Characteristic of this kind of inquiry, instead of direct assimilation, is that the student treats new information as something problematic that needs to be explained (Bereiter & Scardamalia, 1993; Chan, Burtis, & Bereiter, 1997). By imitating practices of scientific research communities, children can be guided to engage in extended processes of question- and explanation-driven inquiry. An essential aspect of this kind of inquiry is to engage collaboratively in improving of shared knowledge objects, i.e., hypotheses, theories, explanations, or interpretations (Scardamalia & Bereiter, 1996). Through intensive collaboration and peer interaction, resources of the whole learning community may be used to facilitate advancement of inquiry. Although scientific inquiry is a prototypical example of progressive inquiry, corresponding process are frequently observed in humanities and many kinds of cultural activities. One has to engage in a process of inquiry whenever there is a problem that cannot be solved with available knowledge. The process of progressive inquiry is similar in a wide variety of cultural activities.

In the following, a conceptual framework of progressive inquiry is outlined and each aspect of inquiry shortly discussed (see Figure 1).

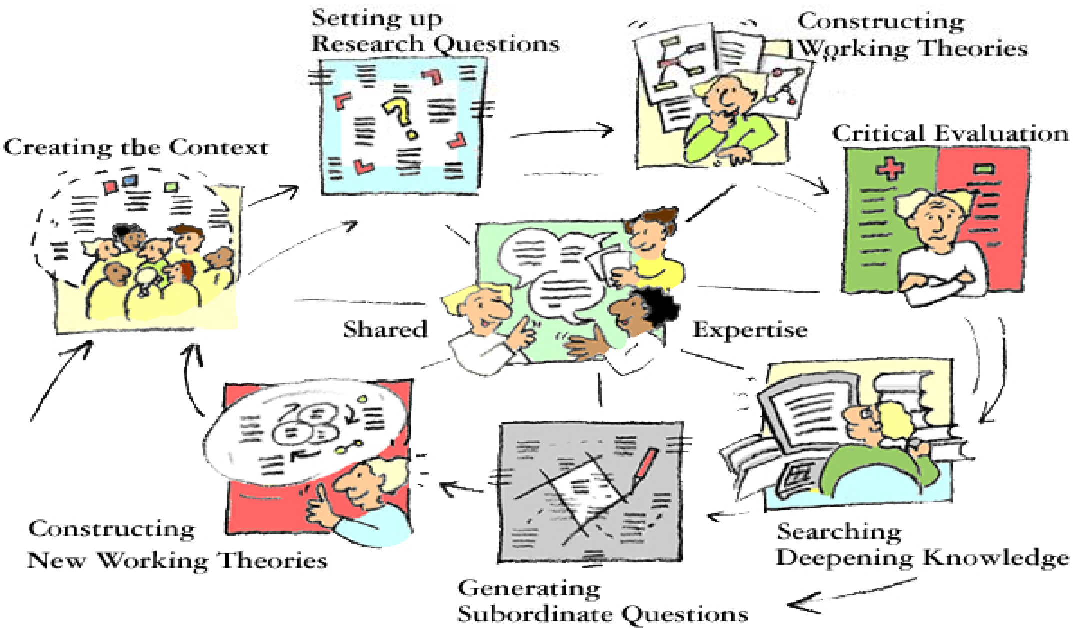

Figure 1. Elements of progressive inquiry.

Creating Context

A starting point of the process of inquiry is creating a context for a study project in order to anchor the problems being investigated to central conceptual principles of the domain of knowledge in question or complex real-world problems solved by experts. The purpose of context creating is to help the students to understand why the issues in question are important and worthwhile to investigate and personally commit to solve the problems being investigated. It is essential that the topic is sufficiently complex and multifaceted so that it can be approached from different perspectives and viewpoints. It is very important to focus inquiry on a problem-area that is central for the students' conceptual understanding and encourage them to take challenging learning tasks that facilitate in-depth conceptual understanding. The context may be created by introducing a critical text or article, showing videos, or presenting stories or teacher's own explanations. It is essential that the teacher does not provide answers to the students directly but gives some general information that helps the students to understand the relevance of the topic being pursued as well as connect it to their own experiences, interests, and background knowledge.

Setting up Research Questions

An essential aspect of progressive inquiry is to set up questions or problems that guide the process of inquiry. Questions that arise from students' own wonderment or their need to understand have a special value in the process of inquiry. Progressive inquiry is facilitated by learning that is focused on working toward more coherent and deeper understanding through overcoming weaknesses and limitations of one's own knowledge (Scardamalia & Bereiter, 1993, 1996). The cognitive value of research questions is based on heuristic guidance provided for the process of inquiry by constraining and directing the search for information. A process of setting up a research question activates a student's background knowledge by facilitating in-depth search of memory. Simultaneously, problem generation facilitates making inferences from one's knowledge. Further, it guides one continuously to relate what he or she already knows to new information (Hintikka, 1982; Sintonen, 1990b; Scardamalia & Bereiter, 1992).

There is evidence that students are able to generate cognitively valuable questions on the condition that they are not required to be able to provide answers to their questions (Scardamalia & Bereiter, 1992). If students are, on the contrary, so required, it is likely that in order to avoid failure and save cognitive effort they would adopt a strategy of asking questions to which they already know an answer or have information very easily available. Hatano and Inagaki (1992) observed, correspondingly, that performance orientation and an immediate need for correct answers is counter-productive from the viewpoint of comprehension activity. Scardamalia and Bereiter's (1991, 1992b) study indicated, further, that if students were asked to generate questions before introducing a new topic, they were likely to ask questions derived from their need to understand and focused on things they were genuinely interested in and wondered about.

Constructing Working Theories
An important aspect of inquiry and a critical condition of developing conceptual understanding is generation of one's own conjectures, hypotheses, theories, or interpretations for the phenomena being investigated (Bruner, 1996; Carey & Smith, 1995; Dunbar & Klahr, 1988; Lampert, 1995; Perkins et al., 1995; Scardamalia & Bereiter, 1989, 1993). Yet, students' own theories do not have a significant role in current educational practices. Engaging students with construction of their own explanations may guide them to see themselves as contributors to knowledge, as prospective scientists (Scardamalia & Bereiter, 1993; Cognition and Technology Group at Vanderbilt, 1993). Construction of students' own hypothesis and conjectures guides students to systematically use their background knowledge and make inferences to extend understanding.

It is very important that educators encourage students to engage in explanation-driven process of inquiry, to generate hypotheses and theories, even if initially mistaken. Each student comes to instructional situations with a large body of preconceptions that diverge from generally accepted scientific ones. These affect considerably how he or she interprets new information. Progressive inquiry is aimed at facilitating explication and externalisation of these preconceptions (through guiding students, for instance, to write about their ideas) and taking them as the object of collaborative discussion. Generation of intuitive explanation before obtaining scientific information makes differences between one's own conceptions and scientific conceptions salient and accessible to the student. If scientific conceptions are assimilated without explicating one's own view, it is likely that potential differences or gaps of knowledge are not at all identified. Consequently, the student is likely to assimilate scientific knowledge without any conceptual restructuring and reproduce misconceptions or wrong theories later on in the process of inquiry.

The process of constructing one's own working theories can be seen as a process of explanation. Cognitive significance of explanation is based on the close connection between explanation and understanding. Craik (1943) and Perkins et al. (1995) argued that understanding is intimately linked with explanation: people demonstrate their understanding by offering explanations. Construction of explanations facilitates elaborate processing of knowledge, i.e., reflecting on, extending, and testing of ideas. Through generating their own conceptions, students are engaged in elaborate processing that establishes connecting cognitive linkages between new knowledge and students' concurrent knowledge, and thereby produces increased coherence and systematicity of knowledge structures. Students are able to genuinely understand scientific explanations studied only by participating themselves in the process of explanation.

Critical evaluation of knowledge advancement
Critical evaluation addresses the need to assess advancement in knowledge-seeking inquiry in a constructive way. Through evaluating whether and how well the working theories explain the chosen problems, the learning community seeks to assess strengths and the weaknesses of different explanations and identify contradictory explanations, gaps of knowledge, and

limitations of the power of intuitive explanation. The evaluation helps the community to direct and regulate joint cognitive efforts toward searching new information that will help advance shared understanding.

Searching New Scientific Information

The question-driven process of inquiry provides heuristic guidance in the search for new scientific information. Considerable advancement of inquiry cannot be made without obtaining new information. Further, large bodies of information cannot be managed without questions that guide and constrain the knowledge-seeking process and help to structure information obtained (Bereiter, 1992). By examining one's problem or intuitive theory with the help of new information, the student may become aware of his or her inadequate presuppositions or background assumptions. A comparison between ones own intuitive and well-established scientific theories tends to make weaknesses and limitations of one's conceptions salient to the students facilitating conceptual progress. Monitoring progress of one's conceptual understanding facilitates metacognitive awareness of the process of inquiry.

Scientific inquiry is a problem-solving process. It follows that a scientific theory or a piece of information can be regarded as an answer to an underlying question. Scientific theories cannot be really understood without understanding the problems for answering to which the theories are constructed. Problems can be seen as "umbrellas under which facts and theories are gathered" (Sintonen, 1985, p. 41). However, current educational practices guide students often, without reflections, to adopt scientific facts and theories only as new items of information to be memorized. However, all scientific information does not have equal cognitive value; explanatory or theoretical knowledge has a key role in conceptual understanding, and, thus, a special status in the cognitive process of inquiry. In order to be successful, educational study projects should explicitly be designed to facilitate adoption of explanatory or theoretical knowledge that enables a student to make sense of the empirical phenomena being investigated. Only by focusing on explanatory knowledge and principles may information overload be overcome.

Engagement in Deepening Inquiry

In pragmatic problem-solving situations one has to start generating questions and tentative theories before all necessary information is available. Therefore, the process of inquiry often has to start with initially very general, unspecified, and "fuzzy" questions and tentative working theories (Sintonen, 1991). In spite of gaps, weaknesses, unclarities, or other limitations, however, these kind of general questions and working theories may function as tools of inquiry and provide a basis for progressive inquiry.

A critical condition for progress is that students focus on improving their theories by generating more specific questions and searching for new information. The process of inquiry advances through transforming the initial big and unspecified questions into subordinate and, frequently, more specific questions. The students try to solve the big question through using their existing knowledge and new information that provide answers to a series of subordinate questions. The dynamic nature of inquiry is, further, based on the fact that generation of intuitive explanations and obtaining of new scientific information make new research questions, that could not have been foreseen in the beginning of inquiry, accessible to the students. By finding answers to subordinate questions, students approach gradually toward answering the big initial question.

Shared expertise

All aspects of inquiry, such as setting up research questions, searching for new scientific information, constructing of one's own working theories or assessing the explanations generated, should be shared with other inquirers. Cognitive research indicates that advancement of inquiry can be substantially elicited by relying on socially distributed cognitive resources, emerging through social interaction between the learners, and collaborative efforts to advance shared understanding. According to Miyake's (1986) analysis, human understanding is iterative in nature, i.e., it emerges through a series of attempts to explain and understand processes and mechanisms being investigated. In a shared problem-solving process, agents who have partial but different information about the problem in question appear both to improve their understanding through social interaction (see also Brown & Palincsar, 1989). Through social interaction, contradictions, inconsistencies, and limitations of students' explanations become available because it forces them to perceive conceptualisations from different points of view. Hatano and Inakagi (1992) as well as Brown and Palincsar (1989; Bielaczyc, Pirolli & Brown, 1994) argued, further, that deep conceptual understanding is also fostered through explaining a problem to other inquirers. In order to explain one's view to his or her peers, an individual student has to commit his- or herself cognitively to some ideas, explicate his or her beliefs, as well as organize and reorganize his or her knowledge (Hatano & Inagaki, 1992). Through this kind of process, inadequacies of one's understanding tend to become more salient.

Further, there is a growing body of evidence that cognitive diversity and distribution of expertise promote knowledge advancement and cognitive growth. Distribution of cognitive efforts allows the community to be more flexible and achieve better results than otherwise would be possible. Moreover, studies of Hutchins (1995) and Dunbar (1995) revealed that groups that consist of members having different but partially overlapping expertise were more effective and innovative than groups with homogeneous expertise. New pedagogical models as well as technology-based learning environments are emerging that are grounded on distributed expertise and which utilize cognitive diversity. The Fostering Communities of Learning approach, developed by Brown and Campione (1994, 1996), is a pedagogical model that is designed to take advantage of distributed expertise and cognitive diversity characteristic of communities of scientific practice. Conceptual advancement is facilitated by cultivating each student's own expertise and guiding the students to reciprocally teach each other. Students engage in a self-regulated and collaborative inquiry being, as a group, responsible for the task. They are guided themselves to monitor progress of their distributed inquiry.

4.3 Overview of the main projects in Finland

During five recent years, there has been a huge increase in the development projects to support virtual learning or virtual working communities. A variety of different platforms that support collaboration has been developed both in governmental educational sector as well as in private companies in Finland. However, majority of these innovations are based on rather unsophisticated and not pedagogically meaningful design principles; they are merely representing the newest technical innovations and solutions.

In this chapter we chose to describe only three major Finnish research projects that has been based on theoretically grounded pedagogical principles and approaches to support teaching and learning with CSCL, including pilot testing phases. We do not go through in detail all the collaborative software development or implementation projects that are on the progress in Finland at present. In the practices described in this chapter, CSCL is not defined just as an innovation based on ICT, it's role has been more like a tool to verify some theoretical assumptions about social knowledge construction and learning.

To support networked learning, the following pieces of software has been used in the Finnish CSCL studies to provide the technical infrastructure of the studies:

- *CSILE and Knowledge Forum*. Computer-Supported Intentional Learning Environments (CSILE) is a local-network environment for building, articulating, exploring, and structuring knowledge. CSILE and its new generation version, Knowledge Forum, are developed at the Centre for Applied Cognitive Science, University of Toronto (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989).
- *Virtual Web School* (VWS). The VWS is a www-based environment for storing and sharing information by using discussion forums, electronic portfolios, and chat, designed and developed by the Media Centre of Helsinki City Department of Education.

- Workmates is a www-based tool for facilitating collaborative learning by sharing and commenting documents developed in the Unit for Educational Technology at the University of Turku (www).
- FLE2 Groupware. (Future Learning Environments). The software has been published by the UIAH Media Lab, University of Arts and Design, Helsinki at http://fle2.uiah.fi.

4.3.1 Cognitive and motivational effects of computer-supported collaborative learning
(Software used: CSILE, Knowledge Forum, Workmates and Virtual Web School)

This is a three-year project that focuses on analysing cognitive and motivational effects of CSCL environments and developing, analysing and evaluating pedagogical practices within them. The project is funded by the Academy of Finland. The main research tasks of the project can be summarised as the following:

1) developing pedagogical practices and models of using CSCL;
2) analysing cognitive effects of CSCL;
3) analysing social and motivational effects of CSCL, and
4) analysing cognitive design principles of CSCL.

The study has been carried out through implementing networked learning environments in primary and secondary school levels, and analysing thoroughly students' learning activities, particularly knowledge production and peer interaction, in the context of the CSCL. The participating study groups have been from three different cities, and from five different schools. The project started in the beginning of year 1999 and will end at the end of year 2001. The final report of the project will be published during the year 2001. The findings that have already been reported can be divided into two main categories: 1) students' cognitive-strategic processes and cognitive engagement, and 2) students' motivational processes.

The studies related to the first category emphasize students' collaborative knowledge construction practices, communication patterns and participation, and students' strategic actions. The results of these studies indicate substantial differences in the students' participation activity, the quality of common knowledge construction being rather superficial, and the discussion threads appearing to be quite short (Lipponen, 2000; Lipponen, Rahikainen, Hakkarainen, & Palonen, in press). Even though students were able to use technical tools to share their knowledge, and in some studies discussion threads were longer than on average, students seemed to stress their own learning processes more than social knowledge construction (Salo & Järvelä, 2001). It is not self-evident that students start spontaneously to collaborate in an equal and productive way, when they are provided with tasks and tools to work as a cognitive group. However, this new way to arrange the learning environment seems to encourage some students to change their behavioural patterns, to use more high-level strategic patterns of inquiry and to engage in a discussion aiming at knowledge construction (Salovaara & Järvelä, submitted).

In one middle school distant learning project (see Lakkala, Ilomäki, Lallimo & Hakkarainen, in press), where students collaborated mainly virtually with each other in a progressive inquiry project, the content of communication concentrated on organizing the learning community and the group processes rather than on epistemological subject matter issues. This result emphasizes problems of creating a learning community for students collaborating at distance. In addition, the tension between the conventional school culture and the novel inquiry practices applied in the project, affected students' participation, and patterns of activity.

Within the second category, the studies focus on motivational dimensions, such as motivational engagement and students' coping tendencies. The main results related to motivation indicate that although a new kind of pedagogical environment is not able to directly contribute to students' learning orientation, it may have systemic effects on students' ways of interpreting the learning situation. Further, the results also indicate that learning oriented students are showing progressive coping and engagement, whereas the non-learning oriented students seem slowly to adopt the working procedures belonging to collaborative knowledge construction (Järvelä & Niemivirta, 2001; Järvelä, Niemivirta, & Hakkarainen, submitted; Rahikainen, Järvelä, & Salovaara, 2000; Rahikainen, Lallimo, & Hakkarainen, 2001).

4.3.2 CL-Net: Collaborative Learning Networks in Primary and Secondary Education (Software used: Workmates, CSILE and Web Knowledge Forum)

Five different European countries (Belgium, Finland, Greece, Italy and the Netherlands) participated in this project during two years, 1998-1999. The European Community funded the project. The main goals of the project were:

a) To synthesize existing research on computer supported collaborative learning that aims to stimulate knowledge building;
b) To find effective ways to introduce collaborative learning networks in schools;
c) To develop didactical models, design principles and learning scenarios for the use of collaborative learning networks (CLNs) in primary and secondary education:
    1. To experiment with different kinds of CLN-tools which support the learning process and the acquisition of knowledge building skills;
    2. To evaluate the (meta)cognitive, motivational and social effects of collaborative learning, supported by computer networks.
d) To experiment with cross-national communication between schools.

The technology used varied according the participating countries (for more information about the project, see http://www.socsci.kun.nl/~clnet/synopsys.htm). In Finland, there were two test sites participating in the project. One test site located in Helsinki, another in Oulu in Northern Finland. In these schools, CSILE and Web Knowledge Forum were used. The first aim of the research carried out in Finland was to examine how students having different motivational orientation tendencies in traditional school learning cope with challenges and possibilities of knowledge building processes created by computer supported collaborative learning. The second aim was to develop process-oriented methods for studying motivation and cognitive engagement in CSCL.

The studies had relatively short period of data collection, so there are limitations in making conclusions and generalising the results of the Finnish case studies related to this project. Further, the classrooms were not yet completely adapted to the pedagogical culture of CSCL. We believe, however, after conducting several case studies that it is possible to get reliable, realistic and consistent results of students' coping and engagement in computer supported collaborative learning by using adequate methods. General self-report measures and pre-tests helped to identify potential comparable patterns in students coping, but only the process-oriented qualitative data analysis showed the importance of individual and contextual information for understanding how to support student engagement in the processes of knowledge building (Järvelä, Niemivirta & Salovaara, submitted).

To summarize, results of the Finnish case studies indicated that students need a great deal of pedagogical, epistemological, and motivational guidance in order to participate in computer supported collaborative learning and in progressive inquiry. The students cannot be expected to discover these practices by themselves without guidance and expert modelling. However, implementation of practices of CSCL and progressive inquiry to schools is constrained by the fact that also teachers have seldom had personal experience of computer-supported collaboration or become acquainted with the epistemology of scientific inquiry. These considerations suggest that more resources should be invested in teacher training. In order to succeed the teachers may need a great deal of pedagogical and epistemological support from researchers in the form of project design and good examples. Besides theoretical knowledge about CSCL and progressive inquiry, teachers need practical guidelines for promoting these approaches in practice.

One aim in the project was, also, to provide a collaborative tool for the participating researchers. This tool, Workmates, was developed in the Unit for Educational Technology at the University of Turku. The CL-Net community used Workmates 4 from the beginning of the project. More than 30 users from different countries used a version 4 of the software. The development of Workmates was greatly encouraged due to the feedback from this community, and it provided a useful workspace for the researchers to share different documents and develop them further collaboratively. The documents situated in the WM4 instance were organised into several work packages that were used as containers for the contributions. In this asynchronous environment, it was quite easy to comment material made by the researchers of other participating university. However, one of the most used features seemed to be file uploading. The centralisation of material storing was important aspect also because of the CL-Net's truly distributed nature. The Workmates 4 usage gave a lot of valuable feedback about building a CSCL environment, and this experience helped to develop future groupware concepts based on Workmates.

4.3.3 Future Learning Environments

(Software used: FLE2 Groupware)

A new-generation networked learning environment, called the Future Learning Environment (FLE) was developed in collaboration with the Media Laboratory, University of Art and Design, Helsinki, and the Department of Psychology, University of Helsinki. The environment is a web-based groupware system designed for supporting collaborative knowledge building. The primary users of FLE have been university students and people in in-service training at various organizations. The users are able to access it from any internet-linked computer and post ideas and thoughts to FLE database directly or using their standard office applications and productivity tools.

The pedagogical model of *progressive inquiry* has been embedded in the FLE design. The environment provides each student with *Virtual web top* for building students' own knowledge. The working space has direct links to those of the other members of the study group, enabling all to share their process of inquiry. *The Knowledge building module* provides a shared space for working together for solving problems and developing ideas and thoughts generated by the users. Participation in progressive inquiry is facilitated by asking a user who is preparing a discussion message to categorize the message by choosing a *category of inquiry scaffold* (e.g., Problem, Working theory, Summary) corresponding to the progressive inquiry model (based on the practices of Scardamalia & Bereiter, 1993). These scaffolds are designed to encourage students to engage in expert-like processing of knowledge; they help to move beyond simple question-answer discussion and elicit practices of progressive inquiry. *The Jam session* module encourages free flow of ideas and experimentation with different ways of representing knowledge. The environment provides tools for storing different versions of the object being developed, whether it is a design, a project report or some other type of document. The users may take a version of the object and elaborate it further, and save it for the other users to be further develop. The Jam Session module assists in making thinking visible (Brown, Collins, & Duquid, 1989; Scardamalia & Bereiter, 1989) by providing a graphic representation of development of a knowledge object. *The Library* contains course materials chosen by the tutor as well as materials produced by the users. Materials from earlier courses may also be stored in the Library and made accessible to later users.

The work has aimed at developing tools for students and teachers to monitor their own progress and sharing of expertise. The environment has been used in various courses in secondary and higher education, as well as in professional development programs. Research on FLE in university courses has provided positive evidence for a successful integration of progressive inquiry and networked collaboration, but there are also major pedagogical and design challenges. Muukkonen, Hakkarainen and Lakkala (1999) noticed that students were not always able to use cognitive scaffolds adequately. The students showed a bias for selecting a category of inquiry that was very neutral, mostly Comment. More active tutor's participation into the discussion could have significantly changed this pattern. Furthermore, students' productions represented several categories simultaneously. It is possible that it is not natural for the students to partition their posting in a way that corresponds to the given scaffolds. It would be important to further develop the functioning and the types of scaffolds by allowing, for instance, categorisation within a message. An examination of the database indicated, also, that there was a substantial knowledge-management problem. A relatively large number of messages made it difficult to follow the discussion and get an overview of issues being discussed. The fact that discussion was organized around a set of principal problems provided significant help, but an intensive discussion – possibly ten or more steps deep – was laborious to follow. It may be necessary to develop tools that would help to organize the messages.

In a more recent research, the characteristics of university students' inquiry in two conditions involving either computer-supported collaboration or more traditional, individual writing assignments were compared (Muukkonen, Lakkala & Hakkarainen, 2001). Analysis of the knowledge creation processes revealed that the FLE-groups produced a higher proportion of problems and metacomments, but the traditional groups produced a higher proportion of own explanations. It seems that a combination of activities involving CSCL and individual reflection produces more intensive in-depth inquiry processes. Therefore, various methods should be combined in educational settings.

Further, methods for analysing tutor's role in computer-supported collaborative inquiry has been examined in a research connected to FLE project (Lakkala, Muukkonen, Ilomäki, Lallimo, Niemivirta & Hakkarainen, 2001). The results indicated that in networked communication experienced tutors were inclined to take quite traditional role of a teacher who gives general study guidance, instead of participating to deepening epistemological inquiry. Also our other studies on tutoring processes in the context of CSCL has revealed that teachers or tutors do not, frequently, participate very actively in networked learning processes, or they may selectively provide more support for high achieving or female students (Palonen & Hakkarainen, 2000).

4.4 Conclusions

As a conclusion from the projects presented above, we would like to point out especially some issues.

A teacher may have major difficulties guiding students who cannot really externalise their own concepts and the inquiry process itself. It is, of course, important to provide teachers sufficiently concrete models or examples so they can find productive ways of guiding students with varying cognitive and socioemotional skills (Brophy, 1999). However, it is also very important to create proper scaffolds, both in cognitive, and motivational sense, for the students that have difficulties adopting these new working procedures.

The results of our projects also showed the importance of multiple modes of data collection. The different methods and use of several data sets allow the results to converge through triangulation, provide complementary views, and allow the researcher to examine overlapping and different facets of a phenomenon.

Little attention has been given to the technical support for inducing and enhancing participation and interaction in collaboration. Collaborative agents and other entities based on artificial intelligence can provide significant support for collaboration. These intelligent agents may, for instance, make a learner aware of someone who has the same problem or knowledge as the learner, who has a different view of the problem or knowledge, and who has potential to assist him or her in the problem solution. It would be important to provide the learning environment with tools that would allow also the teacher or tutor get a better overview about what is going on in the database during the process.

However, active participation in CSCL is not enough. What should also be promoted is the quality of discourse. This is not easy, as also our studies have showed. We think that there is one central factor in promoting high-level discourse, namely teacher's scaffolding. Teacher is needed to structure learning events and the discourse, to give advice and feedback when needed, verifying and clarifying students' understandings, raising students' awareness about the nature and focus of their communication, and prompting active participation.

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5. The Status of CSCL research and practices in Greece

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5.1 Implementation of ICT in Greek education

The Greek educational system has experienced the introduction of ICT in a series of waves. In the late 80's computers were introduced in secondary education in the context of teaching computer science. In the 90's an ambitious program of ICT introduction, under the name of "Odysseia", was launched by the Greek Ministry of Education. The following is a description of the program taken from its web site (http://odysseia.cti.gr/English/ODYSSEIANEW/about.htm).

> *"Odysseia" is a dynamic, action-oriented programme designed to cultivate and develop the faculty of critical thinking and to change the practices of teaching, learning and communication in Greek schools through the use of computer and network technologies in secondary education.*
>
> *The "Odysseia" Programme is part of the Operational Programme for Education and Initial Vocational Training of the Ministry of National Education and Religious Affairs' and is implemented by the Directorate of Secondary School Studies, the Community Support Framework Directorate, the Pedagogical Institute and the Computer Technology Institute (CTI), which administer the design, technical support and monitor the implementation of the 19 Projects that make up the Programme.*

These Projects are designed to introduce computer and network technologies into the daily school practice of 385 secondary schools in Greece covering every subject on the standard curriculum, in order to create a substantial number of school communities that will have incorporated these technologies as an integral part of their daily teaching and learning practice.

At this point "Odysseia" is still in the process of implementation. Many schools have been equipped with computer labs but these labs are not yet fully operational for lack of adequately trained personnel and educational software. In the meantime, the Ministry of Education has deployed a large program for the training of teachers under the broader goal of supporting the preparation of citizens of the information society. The program consists of three units: one is providing training in computer literacy for large numbers of teachers; the second is addressing the issue of developing pedagogically appropriate uses of software and focuses on specific subject-matter areas; and the third is addressing the need to design more ambitious interdisciplinary projects. At the same time the Pedagogical Institute has created web sites that support inter-school communication (http://ww.sch.gr) and discussion forums (http://www.sch.gr/forums).

The following is a short description of the current state of affairs in Greece with respect to ICT uses in primary and secondary education.

5.1.1 Primary education

Little attention has been paid to the introduction of ICT in primary education from the part of the Ministry of Education. Only one of the 19 programs of "Odysseia" is addressing primary education. The goals of this program is to equip 14 primary schools with computer labs and Internet connections and train teachers that will be able to utilize this technology in the teaching of all subject-matters. At this point the 14 schools have been selected and equipped with computer labs and there is starting to be some limited use of these labs by the teachers of the schools who have been trained to use them.

In the meantime, many primary schools have been equipped with computers through parent and teacher initiatives or through other Local, National or European projects. The situation is the primary schools is changing rapidly from day to day as there is great desire at the local level (municipalities, school districts, school principles, teachers, parents, and of course the students themselves) to use ICT in education. As a result, there are many motivated teachers, mostly on their own and without support from the Ministry, who try to use ICT in various ways. The most common uses of ICT in primary schools today are the following: (a) use of mostly drill and practice software to help in the teaching of the Greek language, mathematics, geography and history; (b) use of logo in mathematics and geometry, (c) use of the Internet for finding of information usually in the context of projects dealing with the local history and culture or with the environment; (d) the creation of school web pages and school newspapers.

These initiatives are slowly changing the austere teacher-centred learning environment of the Greek primary school. They provide the opportunities for greater and better communication between teachers and students and for the students to collaborate with each other as they work for common projects. These interactions have not been researched so far, with the exception of a recent study in the context of the European project EMILE that studies this type of grass-roots innovation.

5.1.2 Secondary education

There are two levels of secondary education in the Greek educational system: the high school, from ages 12 to 15, and the lyceum, from ages 15 to 18. Students in the lyceum are totally preoccupied with the preparation for the national exams that will give them entry to the Universities. There is little room for innovation at this level. There is greater room for experimentation with uses of ICT at the high school level.

At this point practically all high schools in Greece have a computer lab that is used for teaching computer science. In some schools, these labs are also available to the other teachers for use in the teaching of various subjects, but this does not happen very often. Most of the “Odysseia” computer labs that come with better computers and Internet connections are now in place in approximately 400 schools all over Greece. These labs are not yet fully operational and are waiting for the “computer animators” to start using them and make them available to the other teachers. Towards this direction, one of the “Odysseia” projects concentrated on the preparation of “computer animators” for the 400 schools of the Program. Their training lasted for one full year and was directed by three Universities in three different locations. Their training time included courses in the University campus and supervised mentoring activity in the schools they were responsible for. A total of 120 “computer animators” are trained in this fashion and are expected to be able to support, at different levels of thoroughness, many disciplines. The positive reaction from the side of the teachers to the work of the first “animators” convinces us that there is certainly going to be much greater use of ICT for the teaching in the various disciplines in the next couple of years.

As the government initiatives are being slowly implemented, the individual school initiatives witnessed in primary education are also happening at the high school level. Through local, national or European funds, some teachers are equipping their schools with computers, get Internet connections, participate in European projects, create school web pages and school newspapers, and initiate projects about the local history and culture. These innovations have positive effects on the high school learning environment and create opportunities for greater student collaboration. It is also obvious that they lack theoretical depth and they are not adequate in dealing with the deeper pedagogical and learning challenges of secondary education.

5.2 Theoretical principles and models for CSCL in Greece

A number of researchers are working in Greece to design software and learning environments for computer supported collaborative learning. Most are guided in their efforts by Vygotskian ideas regarding the importance of social collaboration and the ideas of distributed cognition. This work has been successful in producing some tools and some learning environments mainly for kindergarten and primary school children (Vosniadou et al., 2000; Kollias et al., 1999; Kollias et al., 2001; Kynigos et al., 2001a; Kynigos et al, 2001b).

Three tools that are presented later in the description of case studies are:

1. The *Representation Tool* developed in the University of Patras (Fidas and Komis, 2001). This is an open-ended, internet-based, educational software for collaborative concept mapping. The Tool provides for the rapid development and exchange of concept maps through its common working environment. In the description of this work later in this report, we refer to the pedagogical principles used for its design and the components that comprise it.

2. A technology for connecting Geographical Positioning Systems (GPS), through a special kind of network (a GSM network)[3], to local PC software, based on the "E-slate" environment (http://E-Slate.cti.gr) which was developed in the Computer Technology Institute (CTI). This software also supports map creation and editing)[1]

3. A variety of micro-worlds created through the "E-slate" environment (http://E-Slate.cti.gr)

The group working with Vosniadou and her collaborators has tried to provide a theoretical framework for connecting CSCL approaches with the conceptual change movement particularly in science and mathematics. The fundamental idea behind this attempt is that the distinction between the "acquisition" and "participation" metaphors of learning is a misguided one, as learning depends crucially on both acquisition and participation. It does not make sense to think of individuals as brainless pawns, thoughtlessly reacting to environmental stimuli, tools or other individuals. Social participation is guided by what we already know and differs with changes in age and acquisition of expertise. At the same time, social participation and participation in the practices of a community, is probably the most important way of acquiring new knowledge (Vosniadou, 2001; Vosniadou et al., 2001). We call this the "acquisition through participation" paradigm.

The experimental projects designed to investigate CSCL environments from the point of view of the "acquisition through participation" paradigm have been constructed around the uses of the software Knowledge Forum developed by Scardamalia and Bereiter. In this work extensive observations and videotapes were made of elementary students collaborating in the process of various science concepts. Analysis of the students' discourse during collaboration as well as various analyses of their notes exchanged through the use of Knowledge Forum revealed that the main gain of CSCL types of educational activities, as compared to traditional methods, lie in the areas of metacognition and self-regulation. In other words, students collaborated to plan their activities, to design how they were going to respond to the other students' notes in Knowledge Forum, to solve various problems related to the completion of their projects, etc. (Vosniadou, et al., 1999).

[3] This technology has been developed in the E-slate environment, http://E-Slate.cti.gr, http://www.cti.gr/RD3/C3

5.3 Overview of the main projects in Greece

5.3.1 Collaborative Learning Networks in Primary and Secondary Education (CL-Net)

In this research project a software specially designed to support collaboration (WebKF[4]) was introduced in a learning environment that had already been formulated for teaching science on the basis of research on conceptual change (Kollias et al., 1999; Kollias et al., 2001; Vosniadou et al, 2000; Vosniadou et al. 2001).

The following design principles were selected as particularly significant:

- Transfer of the responsibility to learn from the teacher to the student
- Support the expression and use of prior knowledge
- Authentic activities
- Creation of an information-rich environment
- Motivational support through collaborative activities and presentations to an audience
- Support to metacognitive development through collaboration and social interaction

The participating students were 6th graders. Each class performed different investigations: understanding the mechanism of the internal heating system, selecting a place in the solar system to construct a hotel, selecting alternative ways for heating their homes.

All the interventions had a four-module structure and lasted a total of 16 hours.

1. The students were taught how to use the software in the context of some initial activities.
2. A note by the researcher started the discussion about the subject under investigation. After the students started commenting on each other's notes, the researcher and the teacher took mainly the role of co-ordinating the discussion and of pointing out discrepancies and inconsistencies.
3. The student dyads were combined in larger groups of approximately six children and were asked to prepare a project to demonstrate the working of the heating system using both text and a drawing.
4. The students presented their projects to their peers and to another 6th grade class of their school.

The following is a description of a part of the "internal heating system" activity:

> *After having visited the internal heating system of the school and gathered information that students are asked to imagine that they are moving inside the internal heating system of their homes, starting from the boiler, moving around and then coming back. They are called to write in dyads what they experience as they do so, how is temperature changing at different locations and what are the regions where they "see" heat coming in or going out. They are then going to comment on each other's notes, asking for clarifications or proposing improvements, try to learn from each other and try to improve their own description of the trip inside the internal heating system.*

The students were working in dyads with one PC for each dyad. WebKF allowed them to have a written account of their ongoing investigation and to comment on each other's notes. They also used word processing and drawing software.

In the process of the investigation the students interacted in various environments: in pairs in front of the computer constructing notes, as dyads by use of the software commenting and contributing on each-others notes, in the classroom while discussing among themselves, in small groups while preparing their final presentations and in front of an audience when presenting their work.

[4] http://fcis.oise.utoronto.ca/~cbrett/WebKF/

Moreover the roles of the students have changed: the students had the main responsibility of the progress of the investigation while the teacher was only pointing to inconsistencies or suggesting to dyads possibilities of collaboration based on their notes. He also was commenting on the quality of their collaboration.

The researchers found that the design of the intervention lead to interesting activities in all the different communication environments that were implemented.

Discussion through the software: Argumentation by use of various information sources
We also detected signs of deeper argumentation.

> *The two groups discuss about a trip inside the internal heating system and the heat exchanges experienced.*
> *Group1: We imagine that we are in the depths of the internal heating system and we move inside the hot waters. The water starts getting hot in the boiler. Then it becomes steam, passes through the heaters and makes it hot. Then when the water is cool it goes back to the boiler and the whole cycle starts again.*
> *Group2: Last time when we went to see the heating system of the school, the technician told us that the water that leaves the boiler is at 75C. So the water has not become steam.*

Discussion through the software: Evaluating their own understanding and the understanding of others

> *Different posted remarks*
> *"We do not know how heat is different from temperature. Who will help us with this difficult question?"*
> *"We think that you have written too little. You have not satisfied us"*
> *"Where does heat enter in and where does it go out?"*
>
> *Group1: We would like more information because we think that you have not developed the subject enough.*
> *Group2: What exactly would you like us to write?*

Discus*sion inside a dyad: Two students discuss on the basis of the notes that they have kept about which planet would be the best to locate a hotel at.*

> *S1: Let us go to Pluto*
> *S2: But it is very far away from the Sun.*
> *S1: It is frozen, so…*
> *[They both look at their notes]*
> *S1: Maybe to Saturn. What is the temperature?*
> *S2: We have not found it.*
> *S1: Gravity is good but not temperature (she mentions some temperatures)*
> *S2: We will freeze*
> *S1: Where should we locate it? [The hotel]. Saturn has good gravity but not good temperature. Why didn't you write down all the temperatures?*
> *S2: Some were extreme. I did not write them. Miss, does the atmospheric pressure matters at all?*
> *Teacher: Hm! I am not sure.*
> *S1: Let us take one thing at a time.*

Discussing with the teacher: Judging evidence.

> *They are discussing on a NASA web page with information about the planet Mars. They see a picture of the planet where it seems like seeing a face.*
> *S1: This is like a sculptured man. A face on Mars! How is this possible?*

Teacher: How do they explain it?
S1: [Reads something that is not really related to an explanation]
Teacher: [Suggests the region where it talks about the influence of the wind]
S2: So this is caused by the wind and…
S1: But how is it ever possible that the wind could do something like that! It is impossible! The wind something like that!
Teacher: And how do they know?
S1: How do they know?
Teacher: The scientists. How did they think of this explanation?
S1: Aha! They thought of it! They do not have proofs to rely on!
Teacher: But we do not have proofs that there are people on Mars either..
S1: Yes, but him? How did they found him?
Teacher: How did they take the picture?
S1: {Continues thinking, then calls S2 who is socializing to come and think with him]

A more quantitative analysis of the various data sources (questionnaires, student notes, ethnographic notes, video and audio tapes) revealed that students improved

- in the information sources that they are willing to consider in order to learn something new
- in assessing whether they have understood something, moving away from "validation that comes from an external source" towards "validation is emerging in a communicating environment" through the intermediate attitudes "validation comes internally as a feeling" and "validation comes internally and the validation strategy can be expressed".

Moreover, the researchers found a correlation between the quality of collaboration in the dyads and the degree of cognitive and metacognitive comments that the students were making. Finally, the analysis of students' written notes and transcribed intra-dyad talk showed that the amount and quality of metacognitive comments was atypical compared to traditional Greek classrooms.

It is also significant that although Greek students were not used in been given so much initiative, they both had learning gains and they said that they enjoyed the new learning environment.

However, it was also realized that both students and teachers were transferring practices from the traditional classroom to the new learning environment:

- students felt uncomfortable with sharing knowledge or taking other students' comments and combining them to their own contributions
- teachers felt uncomfortable with students expressing their misconceptions and discussing about them without the teachers' intervention to tell what is right.

Finally, the researchers reported difficulties with far transfer of the cognitive gains.

5.3.2 Collaborate concept map building

(http://hermes.iacm.forth.gr)

The researchers constructed a software, *Representation Tool* (Komis et al., 2001; Fidas and Komis, 2001; Fidas et al., 2001), an open ended educational software for collaborative concept mapping, based on the Internet.

The architecture of the system consists of six distinct components

- A collaboration component for the real-time distant development of concept maps
- A component for synchronous and asynchronous collaboration and communication
- A component for concept maps handling

- A component for handling and creating objects,
- A component for handling links and
- A special handling component used by teachers or researchers

In designing this tool, the researchers used the following pedagogical principles:

- Open learning software for collaborative learning (Dillenbourg et al., 1996) and conceptual mapping: The representation Tool is an open learning software that provides the potential to its users to use it as a cognitive and representational tool which supports, guides and aids expression of ideas and representations while enforcing cognition and culture (Fisher et al, 2000).
- Expression and investigation through multiple external representations and direct manipulation: The Representation Tool allows the expression and investigation of ideas and understanding of students through the manipulation of simultaneous multiple representations (Southers, 1999) of analogical and symbolic form.
- Support of collaborative learning and distributed knowledge (Scardamalia and Bereiter, 1994; Baker and Lund, 1997) with real time collaboration over concept maps: The working environment of the Representation Tool constitutes a collaborative environment for networked users, either locally or in the Internet. Distance collaboration is supported by appropriate communication tools.

Till now the researchers have only reported one case study with two pairs of 5th grade students (Komis and Fidas 2001). The two pairs collaborated from different locations in constructing a conceptual map with the subject: “What is a computer”. Although the software was supporting the students with both synchronous and asynchronous ways, there were no other means of communication between the dyads apart from those provided by the software. Students worked by themselves and there was no adult intervention.

The researchers are in a preliminary phase of analysis of their results. Their main result till now was that although students have been engaged in problem solving activity relevant to determining the concept map that represents “what the computer is” within the dyads, the inter-dyad communication was poor, dominated by expressions of discord and with no care to arrive in common agreement. Therefore, the construction of a common final product (the concept map) proved to be inadequate by itself to motivate interesting collaboration between the dyads.

In interpreting this result, the researchers focus on the poor self-regulative skills of the students to monitor and evaluate the progress of the work and on the regulation of communication. In both cases they propose rather teacher-centered solutions.

With respect to metacognitive regulation, they propose adult intervention that would make salient significant questions that were left unnoticed by the students and would provoke them by asking explanations. With respect to communication regulation, they again propose adult intervention that would facilitate interaction and communication. They also introduce the issue of structuring computer collaboration through specific phrases or words so as achieve focusing of the discussion in the task involved.

However there is no planning directed towards supporting in students themselves the development of self-regulatory skills for metacognition and communication

5.3.3 The “Children in Choros and Chronos” Project

(Esprit LTR, Experimental School Environments. Reports of deliverables are available in www.cti.gr/RD3/C3/C3_internal.htm; Kynigos et al. 2001a.)

Within this project two research groups concentrated in designing environments with the cognitive goal of map construction, reading and use, “as means to generate meanings of spatial awareness, orientation, symbolization, scale and the representation of objects and events in space”. Each group concentrated in kindergarten and early primary school children respectively. The activities were based on settings of two teams communicating via walkie-talkies: one team wandered around a specific space carrying a Global Positioning System (GPA) device, while the other team observed the exact path-trail travelled by the rover team, in front of their workstation running the activity software. The software provided children with cartography tools that enabled map creation about places, which were not in their immediate vicinity.

> *“Several researchers have doubted the value to introduce mapwork to young children, because of their apparent inability to either perceive maps properly or to understand what they represent. Their results are based mainly on tasks where an already created map is presented to a child. The research project presented re-attributes to the map its communicative status, and aims to explore how map construction and map use in meaningful learning activities, could contribute in map understanding and map related space learning.”*

In designing their activities the researchers concentrated on the following design principles:

- To implicate children in authentic and meaningful activities: the map was used as an instrument that supports communication
- To motivate children through games
- To take advantage of the interaction between collaboration and distribution of cognition: a rich technological environment was developed with maps as artefacts where a lot of knowledge was condensed.
- To support empathy and de-centering: students had to strive towards developing common ground so as to collaborate effectively. To implicate children in the use or the construction of different kinds of maps used in everyday life, and to promote the use of vocabulary and concepts related to space (“Change of perspective” is a sociocognitive construct that seems particularly useful: The creator of a map needs foreseeing the challenges that the user will face and to make the appropriate decisions relative to map design.).
- To take advantage of the support offered by technology with respect to difficult activities such as measurement or changes of scale.

In the case of kindergarten students' activities were distinguished in preliminary activities (which lasted 4 meetings) and main activities (which lasted 8 meetings). The goal of the preliminary activities was to familiarize the students with the context, the software, and the genre of challenges that they would face in the main activities.

The following is an example of part of a main activity called Labyrinth

> *“This activity consisted of 3 parts. The first part concerns the introduction to the new technological learning environment and the operation of the GPS system. In a few words we explain that this tool called GPS shows our position in space so that others can find us. Its antenna (which is covered with a little fabric puppet that called "spirtoulis" - a small very smart mouse-) receives data, information from satellites, which are very high in the sky and send them through this small computer (palmtop) to our computer. This information arrears on the screen of our computer with the form of a line or dots which presented while a little man seen from above walks and leaves behind him traces. We remind them the valiant roamer, the little turtles that had played with them two weeks ago.*

> *Afterwards, one of the experimenters goes outside where the activities will take place and starts moving around in order that the children see agents' movement on the screen of the computer. Then we explain with details the agent's movements, where his head is when he looks in front etc. The communication between the experimenter who is outside and the experimenter and children that are inside is established via walkie-talkie (The children experimented with walkie-talkies and saw how they work before these activities…"*

In the case of the early primary school students, the intervention lasted 16 hours and there participated two groups of 7-year-old students. The students were chosen with the help of their teachers based on criteria of scholastic competence and cooperativity with other students.

There were used two kinds of activities:" Pattern" and "Treasure hunting".

The following is a description of the Treasure Hunting activity

> *There was a hidden treasure and the two groups, the one that was using the PC and the one that was actually moving in the school yard had to collaborate in order to construct a map of their school that they would further use in order to locate the hidden treasure. Students have both to construct a map and to use it. In this activity there were involved not only the multiple systems of representation and the description of the objects but also the selection of appropriate symbols for representing on the map.*

In the case of the kindergarteners in their preliminary analysis the researchers report that, as expected by the design, children were obliged to think and discuss at two levels, using different kinds of languages and combining different representations. There is reported a change of vocabulary: Initially the children were using imprecise expressions such as "this way" or "that way". Then they used a topological system of reference having as origin their body and finally they used a combination of systems of reference and combination of perspectives. There is also reported a gradual social and conceptual de-centering: children progressing in realizing that it is necessary to "put yourself in the place of" or "to take the role of" in order not to have miscommunication or loss of communication.

In the case of the early primary school children, the activity was more strongly cognitive. Students have access to three systems of representing space: the topographic, the projective, and the Euclidian. The Euclidian system is the most difficult for students to deal with, demanding use of metrics and coordinates. In the topological system, positions are determined in a relative way through comparison with landmarks. In the projective system, the specific view used to see the objects is dominant in determining their positions.

According to the researchers, the analysis of the student dialogues shows:

- Interesting problem solving related to the selection of symbols

  Teacher: Then, how do you select what object, what drawing you will put on the map to show that this for example is a tree and that for example is a garbage can
  Student: Whatever it is you put the same.
  Teacher: You mean that it should be very similar? Why?
  Student: So that the others can understand it too
  Teacher: [Mentions some other issues that may be relevant]
  Student: It doesn't matter because again what matters is that the other understands it, not if it is beautiful.

- Interesting problem solving activity stemming from the effort to develop "common understandings".

- Instances of reflection about the different points of view and the strategies through which a descriptive language that stems directly from the representations involved could be “translated” to be understood by the other group.

  The two students are working in front of the PC communicating with groups in the schoolyard.

  S4wt: We have turned towards the flag
  S1: The flag. They have turned towards the flag
  S4 wt: Behind us is the storeroom
  S1: They are here [she indicates the point on the map] so now they have turned towards the flag
  S2: Let’s tell them move down towards their left hand
  S1: They should go this, this way
  S2: So, if they have turned towards the flag then they should move towards their left hand. Isn’t that so?

However there are no data as yet reflecting the clear change in understanding of concepts relevant to maps and in developing proficiencies of map use.

5.3.4 “Communicating-To-Meet” and “Bridges of Europe”

Both these projects use the e-mail as the main technological support and concentrate on the design characteristics of the environment (Kynigos et al. 2001b).

In ‘Communicating-to-Meet’ (CtM) remotely situated 6^{th} grade classrooms collaborated to plan the exchange of pupil visits. According to the scenario pupils write a joint proposal to a funding agency. The proposal should include a rationale justifying the visits, detailed schedules, financing and activity plans. For all sections, exchange of information and opinions is necessary. Thus, the scenario aims to raise the awareness of a common goal between pupils of a similar age and at different locations engaging them in learning math and geography through joint investigation, communication and construction.”

Besides e-mail, the CtM activity relies on a set of software components appropriate for the scenario’s activities. The functionalities of the components are combined into two Microworlds:

- *The ‘Active Map & Trip Planning’ Microworld*, where pupils work on an electronic road map adding information about the places to visit, by creating a legend with an icon editor and attaching information which is automatically saved in a database linked to the legend. Pupils can manipulate the database data to make the trip schedule, by adding new data organized in fields or by making bar charts.
- *The Trip Cost’ Microworld,* where pupils manipulate a database and graphically represent their results on a coordinate system, in order to reach the best decision on a travel package within the range of their budget.

Each class was divided into five groups:

- Mathematics-Group A (MA), investigating expenses other than travel and accommodation (trip cost activity)
- Mathematics-Group B (MB): investigating the cost of trip fare and lodging (travel and lodging activity)
- Geography-Group A (GA): scheduling the activity with respect to places for visit
- Geography-Group B (GB): constructing the map for the visit.

- Coordination Group (C): monitoring the activity by collecting information from the other groups.

In the BoE scenario, pupils are called to select bridges, build their models and communicate about their projects, via a web site, which includes services such as forums and libraries for uploading work. The main idea of the scenario consists of the following:

Doing: building a model of a bridge through a process characterized by experimentation and generation of meaning with respect to the notions of variable, arcs, curvature and arc size, proportion, intrinsic versus plane conception of curves and semicircles.

Embedding in a theme: search, use of cultural, historical, and structural/architectural information on one or more local bridges. Building a bridge model.

Communicating: discussion on aspects of the theme and aspects of the concepts required to build its model with Logo. Controversial themes such as “do bridges bring peace or tension?”, “can I do more useful things with an arc procedure which has the radius as input or with one which has the turtle turn as input?” will be suggested but also generated by the teachers.

Use of the Site: use and exchange ideas about Bridge construction. Use tools to help build the Bridges. Find information about Bridges and make it public. Discuss interesting and controversial issues concerning the history, the architecture, and the building of the models of the Bridges. Publish the bridge models. Publish the written descriptions of the projects. Uses that will emerge from the schools.

In both of the above projects, the researchers focus on the interaction between communicating and doing. They conclude that students “seem to have a general lack of familiarity with social modes of learning”. They propose certain aspects of classroom practice as particularly important

- The breakdown of the aspect of teachers’ role as the only source of information
- The changing status of information
- The legitimisation of communicating personal experience
- Developing an awareness of the communicative aspects of expression
- The challenging of traditional communicational rituals in classroom norms.

However it is not clear that these are direct points of leverage to achieve improved learning environments or whether they are emerging construals that characterize the quality of the learning environment but it is not clear how they could be manipulated.

5.4 Conclusions

Many of the research projects implemented in Greece seem to be facing similar problems. In all the different designs:

- We have no proven cases of significant progress in conceptual understanding.
- In only one project (CL-Net) do we have quantitative indications of growing metacognitive awareness.
- In many projects, there are instances revealing interesting interactions between collaboration and cognition that, however, need to be analysed more carefully.

Moreover, this research has uncovered broader challenges, such as the following:

- The need to convince teachers that collaborative learning is valuable and that it is important to allow students the freedom to do their own knowledge building.
- To find ways to support students’ efforts in developing the knowledge and strategies to evaluate their own understanding, the shared knowledge objects that they construct, the quality of their communication, and the quality of their collaboration.

- To support the changes of attitudes towards learning and how to assess it, both for teachers and for students. Here there is a challenge for CSCL's new methods to become respectable in the greater school community as well as outside the school.

Apart from practices that have already been pointed out in learning environments, practices that seem to be emerging as interesting are:

- The potential of play both for motivational reasons and for making salient and amenable to change the norms of conduct.
- The potential of combining multiple representations with communication in a meaningful way.
- The potential of communication software to structure communication in well designed ways.

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6. Collaboration, Constructivism, Community: The Three "C" for the CSCL in Italy

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6.1 Implementation of ICT in Italian education

In the 1997 the Italian Ministry of the Public Instruction promoted a Program for Developing Educational Technology. This program was aimed at disseminating the use of technology to support education in the Italian schools in any level. The program is on a large scale and concerns all the school system, with a great economical investment to equip all the schools with computer laboratories and to train teachers.

Despite this great investment, the Italian schools scenario, computers and telecommunication are in the 1999 still scarcely used as educational support. Although a tendency that shows, how technology is gaining more and more relevance in our educational system, is visible, it is not yet considered fundamental in teaching and learning. Technology is still used to carry on marginal activities at school and it is not yet really integrated in the classroom routine.

In the 1999 a research on Information Technology in Education (called SITES) was committed by the IEA (International Association for the Evaluation of Educational Achievement) and executed by the CEDE (National Institute for the evaluation of the Educational Achievement). In this research, a great difference was found in computer accessibility and availability depending on the school level. For example, the student-computer rate in primary school (from 1st to 5th grade) is about 90 students per computer. This means that a school of about 500 students has a computer lab with 5 or 6 computers. At the junior school level (6th to 8th grade) this rate increases to 40 students per computer and in the last year of secondary school (13th grade) we arrive to a rate of 14 students per computer.

This difference becomes even bigger when looking at Internet access and Web-based activities. Those activities are, in general, even less common at schools, with the exception of the high schools: 60% of them are connected to the Internet and they use it regularly. At the elementary level, 90% of students and teachers do not use the Internet and this percentage decreases constantly at higher school levels. During the last year of high school only 40% of students and teachers do not use the Internet.

The teachers do not always perceive that they had reached the goals pursued by introducing the educational technology at school. Common factors of failure, reported by the teachers, are the limited time available to design computer based activities and the difficulty to integrate computers in the classroom's educational practices.

One of the main goals of the 1997-2000 Program for Developing Educational Technology was to get students to master multimedia and communication, proposing activities such as interpersonal communication and collaboration at a distance as fundamentally important. But the final report of the Program, published at the end of the 2000, reveals that even if an increasing number of schools are hocked to the Internet, electronic connections and email exchanges between schools are still not common activities for Italian schools.

In the study, 2145 teachers have been interviewed about the way they use technology with their students. Following are the results of the most common activities: 73% of the teachers use a word processor; 69% use multimedia and CD-Rom; 68% use educational software; 45% search material from the Internet; 35% build hypertext and hypermedia.

Only 12% of the interviewed teachers admitted that they sometimes use the Internet to have exchanges with other schools and teachers. Another survey carried out by the Institute for Educational Technology of the CNR (National Council of Research) shows similar results. Schools are moving towards an educational use of the Internet but very slowly and in a limited way. Experiences of co-operative work using the Internet (4% of the total schools equipped with Internet connection) and of teachers training (30.6%) are still sporadic cases with a limited impact. Most of these experiences are leaded by governmental or academic institutes either by giving funding or employing researchers to monitor the project.

6.2 Theoretical principles and models for CSCL in Italy

The Italian literature about learning has been focused, until the 60's, on the definition of what is learning and on the relationship between learning and teaching (Metelli Di Lallo, 1964). The main effort was to define the borders of the educational science. The risks were to be reduced to just an application of psychology (by using tests and/or questionnaires) or to be too involved into the clinic dimension. To overcome those risks under the methodological point of view, experiments were implemented as research-action, with teachers acting as researchers and bringing a perspective from inside the context; under a theoretical point of view the focus was on the *multidisciplinarity* of the teaching and learning. Along this principle, experiments and researches carried out in the Italian schools were characterized by a psycho-educational dimension, taking into account the diversities due to the curricular content but at the same time looking at the transversal processes.

6.2.1 Collaboration

One of the transversal processes more studied in Italy is the collaboration. Rooted in the Vygotskian ideas about the relevance for learning of the social interaction, collaboration is considered as a way to organize the social interaction in order to have shared meanings and knowledge construction. A considerable research group, leaded by Pontecorvo (Pontecorvo, 1985; Pontecorvo, Ajello and Zucchermaglio, 1991; Fasulo and Pontecorvo, 1999), looked at how collaboration takes place "inside" the group, through the *discourse analysis* between peers and between the teachers and the students. One of the most interesting results of this stream of research is that the discourse itself functions as a socio-cognitive tool.

When in Italy computers started to be considered as tools to support collaboration, the analysis of the discourse around the computer and generated by the computer is still, in the Italian perspective, an important dimension able to describe the computer-based learning processes (Cesareni, 1995).

6.2.2 Constructivism

Another dimension commonly shared between Italian educational researchers to analyse the learning transversal processes is the constructivism. Constructivism in Italy is interpreted as a guiding idea, regulating the learning activities aimed at having end product, either cultural or manufactural. Thanks to this dimension, the evaluation issues moved from testing individual students to analysing the quality and the process that leaded to the construction of a collaborative product. Constructivism becomes co-constructivism in order to underline again the social dimension and the interaction of peers and expert-novice knowledge. This concept allowed an easy disclosure to the cultural dimension (Mantovani, 1998) and pushed the educational psychology to study the complex relationship between educational processes and the social contexts within which the learning occurs (Pontecorvo, 1999).

Computers were introduced into the Italian scenario as a further tool, innovative and with new additional features compared to traditional tools, to support the construction of cultural products. The new products built using computers can be divided into two categories:

a) Products computer-contained. This type of product is not only built through the computer but is visible only on the computer. It is the case of products like hypertext, hypermedia, and CD-Rom (Calvani, 1996);
b) Products computer-mediated. In this case, the computer is only a tool to construct a certain product. Schools magazines, posters, books and other products are built by using the computers just as support to obtain other types of products (Caravita, Ligorio and Palomba, 1995).

The first type of products takes the biggest part of the Italian educational production, with the consequences of producing the perception of computers closely related to that type of products.

When looking at the impact of constructing through computers, again the discourse generated during the constructive activities is considered as an important indicator. Also, it is analysed how the organizational aspects inside of the classrooms are changed by introducing computers and how new practices and new insights about the learning processes are generated around the computer-based activities (Varisco, 1996).

6.2.3 Community development

More recently, computers are seen as tools to develop and sustain communities working at a distance. Organizing the classroom as a community of learners became relevant in the Italian scenario as a further development of the co-constructivism and collaborative dimensions (Ligorio, 1995). The community of learners model, as was designed by Brown and Campione (1994), gave interesting indications about how to increase the number of "agents" interacting around the same task and how to foster the development of higher levels of thinking. Computers inside the community were used to have more partners to communicate with, thus to have larger community than just the classroom (Caravita, Talamo, Ligorio, and Colanzingari, 2000; Cesareni, Ligorio and Pontecorvo, 2000; Ligorio, Cesareni, Talamo, Zucchermaglio, Lauret, Trimpe and Vandermeijden, 2001).

One of the problems found in the attempt to use computers to support "virtual" communities, comes from the attitude to realize products computer-contained, described previously. This attitude seems to interfere with the idea of using computers to communicate. Computers are seen as tools to achieve end products and not to foster the processes necessary to realize a collaborative product. Computers and the Internet are perceived as "windows" to show classroom final products rather than tools to discuss about what to do and to plan collaborative strategies.

6.3 Overview of the main projects in Italy

In recent years some pilot projects based on Computer Supported Collaborative Learning have been implemented in Italy. In the following, some of those projects have been selected on the base of their quality and they are briefly described to give an idea about the best practices in Italy.

6.3.1 TELECOMUNICANDO ti presento i miei tesori
(I show you my treasures by TELECOMMUNICATING)

Presentation. This project started in 1993 as collaboration between Italian Educational Minister and Telecom, the Italian telecommunication company. 15 schools (5 primary schools, 5 junior secondary and 5 senior secondary schools) in Rome, Milan, Genoa, Palermo and

Florence were involved in the project. Schools were connected in a network with both e-mail and ISDN link, and they collaborate in creating a hypermedia product about cultural goods.

Technological equipment. STET-Telecom provided each school with hardware and software for hypertext construction, telecommunication and videoconferences.

Educational Aims. The aim of the project is to experiment and to enhance new forms of communication and collaboration between schools. In each school students of different levels (from 3rd to 12th grade) are involved in a shared project: to investigate and collect information about a cultural good of their environment, to plan and develop an hypermedia, to communicate with students of other schools in order to project and develop a shared hypermedia.

The importance of this project is also to involve teachers as researchers, collaborating with 5 research centers, one in each town. Three of this Research Centers are responsible of a research sector. The Educational Technology Institute of CNR (National Research Council) in Genoa was charged to monitor and enhance telecommunication and videoconferences communication. The Department of Education, University of Florence, was responsible for hypermedia developing; they were the teachers' and students' referents in developing conceptual maps, organize information and so on. The Department of Psychology of Developmental and Social Processes was charged to evaluate metacognitive, motivational, and social effects of collaborative learning.

After 3 years of experimentation, teachers of the 15 schools are now in charge of being the tutors of teachers from other 30 new schools involved in the project.

Results. The project has been monitored (Talamo, 1998): cognitive, metacognitive, and social skills have been evaluated during the project as well as at the end of the pilot phase (lasted three years). Qualitative analysis of talk in interaction has been done on experimental planning sessions while children were working in small groups. Results highlighted an effect of the participation at the project, in that children are seen to deploy different skills in the social organization of work, in the management of information, in the construction of the product. Also the quality of collective reasoning seems to indicate that children working in the project show a great interdependence in working together as they share mapping models, expressive choices, and they recognize the added value of working as a group (Talamo and Fasulo, in press).

6.3.2 Scambi (Exchanges)

Presentation. This project started in the 1992 and lasted two years. It was designed by a research group of National Council of Research composed by educators, teachers, psychologists and biologists. Nine classrooms from four different schools located in Rome were involved. Students' age ranged from 8 to 10, and they were all at the elementary level. All the classrooms involved had different features in terms of teaching style (traditional versus collaborative), social and economical level and students' competencies (i.e. one of the classrooms involved was composed by deaf kids).

Technological equipment. Traditional technology was combined to more advanced technology. The technology used was of two different types: a) to communicate; various types of software, such as email and a discussion forum and fax as well as normal mail; b) to produce educational materials, such as word processors and a software for professional layout (Page Maker).

Educational Aims. Main goal of the project was to enhance collaborative learning among classrooms with different features and all at a distance. The collaboration was fostered by giving students a task to construct together some common products. Students, teachers, and researchers formed a community of learners committed to producing collaborative products by integrating each classroom's contribution. The topic developed was within the science curriculum, in particular about water. Each classroom decided to work on a specific part of the common topic (water and plants; water and human being; water as chemical element and so on). All the information gathered in the classroom was shared through the communication tools available. The community was enlarged by the participation of experts from the local zoo, some parents willing to contribute with their competences (i.e. of the parents was a gardener and he could give information about the water and the plants), and all researchers involved that acted as persons that could be consulted. It was also fostered an integrated use of all the different communication tools and the different software and knowledge sources available. Some classrooms from the some schools were used as control group and they were tested in particular about the changes in the metacognitive skills.

Results. A broad community of learners was set during the two years project (Caravita, Ligorio and Palomba, 1993; Caravita and Palomba, 1994). Several cultural products were realized during the project.

- An electronic bulletin called "Hints and tricks". The bulletin was used a communication toll to make visible to classroom work. Each classroom had a space were they inserted, every other week, a summary of what was done in the classroom. In this space students were also encouraged by the teachers and the researchers to put questions and request of suggestion. The construction of collaborative products happened by different phases of communication along which partners get to know each other, discuss what to do, share the information and plan how to integrate single contributions.

- A book called "I didn't know". The book was a good way to integrate the individual work into a collective and collaborative product. The process of producing the book was long and complex. First of all the whole community decided together, through different drafts, the table of index of the book. Each classroom took charge of one chapter, but the collaboration with other classrooms was required to revise the work critically both under the style point of view and about the content. Each part of the book was discussed collectively: the title, the cover, the colours, and the style. The whole book was edited by some of the classrooms participating to the project by using appropriate software (PageMaker), and it was sent out for the printing to a bookbindery.

- The analysis of the building process showed that it was necessary to alternate individual, small groups and classroom activities. The communication went through different phases: from a more personal communication to the discussion about specific educational contents.

When compared to the control group, the classrooms participating to the project showed more complex perception of what is and where is knowledge (Ligorio and Caravita, 1994; Ligorio and Caravita, 1995). Non-experimental classrooms perceived knowledge as static and they thought that knowledge is mainly contained in external sources (books, teachers, and so on). The project classrooms could use their thinking and their opinions as knowledge source and they could use their knowledge to analyse and interpret the knowledge contained in the external sources.

6.3.3 Our World

Presentation. The project is devoted to the development of a constructivist theory on the knowledge building. A specific task on environmental education was aimed at making students become aware of the systemic character of urban environment. Three schools (a primary and a junior school in Rome and a primary school in Bari) were connected via a groupware on the Internet.

"OUR WORLD" is designed as a website that affords four facilities to students: a library split into five databases where to find information ("esplorare il mondo dentro e fuori la scuola" = "exploring world in and out of school"), a forum space ("discutere con gli altri" = "discuss with others"), a data-entry space ("produrre informazioni" = "inserting information"), and an address book ("cercare indirizzi per comunicare" = "finding people to communicate with"). The software shares the educational principles of CSILE (Scardamalia & Bereiter, 1989; 1993; Scardamalia, Bereiter & Lamon, 1994). The organization of the database has taken into account categories accepted in the ecological field and young students' knowledge. Information can be browsed, stored, produced, classified, downloaded, and linked to pre-existing files. The forum environment can be the "place" where the students' community engages in metacognitive reasoning and shares the information at a distance. The full communication flow can be visualized in order to reconstruct the knowledge building process, but it is also possible to choose the message children want to react to. In this way, a non-linear sequence of messages can be created.

Technological equipment. Students worked in technology lab inside the schools provided with local networks. Each lab was also provided with an Internet connection.

Educational Aims. Environmental Education should not be included as a separate subject within the syllabus, but it should be regarded as a set of trans-disciplinary objectives aimed at promoting the growth of attitudes, values, and thinking tools. Aim of the project is that children become aware of the many components, variables, constraints that shape even very simple environments in which they actively and passively participate and that they learn to question themselves about the interplay, about what produces and what hinders change.

It is altogether important that students realize the benefit of comparing similar environments in order to abstract commonalities and recognize peculiarities, to tentatively infer causes. Comparison means also to be confronted with the many ways of viewing the same environment by different participants who have different stories and therefore needs and expectations. The use of the full web site was thought as able to enact a range of activities in the school classes, such as:

- retrieving documents from the database
- reading and commenting the retrieved documents
- writing documents to be sent to the editorial board of the database
- filing documents in the database
- participating in forum exchanges: opening a forum and reading/writing contributions to a forum.

The specific contribution introduced in the learning environment by these tasks and by collaboration across classes has been the main target of our investigation.

6.3.4 Our Castle

Presentation. This project was part of the CL-Net (Computer Supported Collaborative Learning Networks) project, funded by the European Community. The project started in the 1998 and lasted two years. Five schools were involved in the project, with 118 students from fourth to seventh grade (9-13 years old). The schools were in two different towns, Rome and Bari, and they were connected in a network and collaborated in creating a Hypermedia product about Middle Ages Castles.

Technological equipment. Students used word processor, software for drawing, painting and software for hypermedia construction in order to produce materials to exchange with others. Our Castle was the name of a web site where kids exchanged information and materials. It was organized as a database where students' contributions can be stored, browsed and downloaded. The web pages were integrated with a discussion forum, Web Knowledge Forum, designed by Scardamalia and Bereiter (1994). In this forum, children discussed their and other classes' contributions and they decided together, how to project and build the hypertext about the castle.

Educational Aims. Main goal of the project was to enhance collaborative learning within and between classes, creating a community of learners between the different classes participating to the activity. The community had a shared task: to project and build a hypermedia product about Middle Age Castles. Children had to collect historical information and share and discuss it with others. Each class decided to work on a specific topic, based on interests and ideas aroused by the kids or given by the context and the situation. For example, the elementary school in Bari focused on the castles in their own region, visiting castles and observing pictures. They gave an important contribution to the discussion, observing that some of the pictures that the other children draw were not in accord of "defense principles" that they observed in castles.

In order to achieve the goal of distance co-costruction of knowledge it was very important to create a community between teachers and researchers. There were periodical meetings between teachers and researchers and there was a Web forum reserved for them. They discussed pedagogical issues, sharing the idea that teachers role had to change: teachers role was to act in the class as a facilitator and a co-learner: to support children's' learning providing them materials, stimulating discussions and organising team working.

Results. A simple Hypermedia product about Middle Ages castles was implemented by the community of learners. In addition, web pages were filled with a lot of historical information. Students improved their knowledge in history, as was shown both with a knowledge acquisition questionnaire and with an analysis of groups' discussions. The researchers observed collaborative construction of knowledge both from audio/video recordings of interactions and from the analyses of the web site materials. To let the activity go on, it was fundamental to create a community between teachers and researchers, sharing problems and discussing didactic objectives and results.

The most successful result of the experiment was that the activity has been continued in the 1999/2000 school year, with a very light monitoring by the researchers.

6.3.5 Euroland

Presentation. Euroland (http://www.garamond.it/euroland) is a joint project between Italy and The Netherlands funded by the European Community. The project lasted 1 year (1999-2000) and was realized with the technical support of the Garamond s.r.l and the University of Rome (IT). Seven schools, four from Italy, and three from The Netherlands, participated to the project with different modalities. The youngest students participating were 9 years old and the oldest 14. In any case, a small group of students (from 2 to 10) was selected from each classroom, and they were allowed to connect to the virtual worlds as citizens with building rights, in behalf of the rest of the classroom. For each student group, at least one teacher was actively involved on-line, and often other teachers were supporting the off-line activities related to the project. In total, the community of Euroland was composed by 40 students connecting to the virtual world, 18 teachers (but only 6 were active on-line) and 7 researchers with different functions: four of them acted on-line and as classroom observers and three of them as tutors on-line, including the project manager.

Technological equipment. The software chosen for this project is called Active Worlds (AW) (http://www.activeworlds.com). AW is an educational, three-dimensional and not immerse type of virtual reality software fostering collaborative learning at a distance, enabling students from schools apart to work together, collaborate and to communicate synchronically. AW is a desktop software very user-oriented that allows to walk through, navigate, fly, and see virtual objects. Once connected to the virtual environment created by the software, users can see themselves represented by an "Avatar" that moves around, acts, and chats with the other users. AW was integrated to a discussion forum, Web Knowledge Forum (KF), designed by Scardamalia and Bereiter (1994). KF supports knowledge building through notes posted in a communal database and visualizes the "tree" of notes and replies.

Educational Aims. This project was aimed at sustaining a cross-national community and the collaborative learning among schools. The community involved in this project was required to build a virtual world called Euroland that was completely empty at its outset. Through on-line discussions, monitored by the on-line tutors, and classroom brainstorming, guided by the teachers, the students decided what to build in Euroland: the Italian and Dutch houses of music, food, art, sport and a travel agency. In order to support the collaboration at a distance, students from one country were required to take charge of the cultural houses of the other country. All the students were required to supervise and contribute to all the houses. In this way, partners were made positively "interdependent" on each other (Salomon, 1993). By filling Euroland with virtual houses about different cultural contents, the project had a strong multidisciplinary nature. In this way also the collaboration among the teachers was triggered: both collaboration among teachers of the same school and collaboration at a distance among teachers from different schools and countries.

Students involved in this project were supposed to acquire communication skills, ability to perceive partner at a distance, and improve their sense of belonging to a broader community based on VR.

Results. Main results of this project can be considered the creation of the virtual world. The community was able to achieve most of the goals that were set by the community self, although some changes were made as a negotiation process, and to fulfill some of the needs raised during the life in Euroland. More analytic analysis allowed us to found obtained so far are focused on:

1. Collaborative learning. The collaborative learning is shown by the content of the virtual houses. Although for each house there was a classroom in charge of its construction, the contribution of all the other classrooms was clearly visible. The content of each house combined contributions from all the classrooms participating (Ligorio and Cesareni, in preparation; Ligorio, in preparation);

2. The emerging of a community strongly guided by the on-line tutors (Talamo, Zucchermaglio and Ligorio, in press; Ligorio, Talamo and Simons, submitted);

3. How the communication formats available within the project (textual versus iconic; synchronous versus asynchronous) were combined (Ligorio, in press) and integrated to each other (Ligorio and Vandermeijde, in preparation);

4. How the virtual identities were played in a virtual environment where users are embodied into Avatars and where the overall task was strictly educational (Talamo and Ligorio, 2001);

5. How the virtual dimension was perceived, and what relationships it had with the reality of the educational objects planned in the classroom and built in the virtual space (Ligorio and Talamo, submitted).

6.3.6 Edelweiss

Edelweiss. Educational Technology & Schooling in Hospital, a project for the testing of new communication and computer technologies in the hospital environment with the aim of supporting children and teenagers in educational activities, communication and play.
The EDELWEISS Project was initiated by the Institute for Educational Technology (ITD) of Italy's National Research Council (CNR) with sponsorship from Hewlett Packard Italy, and Elis. It was carried out jointly with the Genoa-Sturla Local Education Board, encompassing the Gaslini Children's Hospital school and Govi Primary School in Genoa.

The EDELWEISS Project's main objective is to help improve living conditions for hospitalised children by using the computer for communication, expression, learning, leisure, play and so on. The main activity carried out in Genoa to date within the EDELWEISS Project has been computer-aided distance communication between hospitalised children on the one hand and various schools on the other. The children have had a chance to talk to one another and exchange messages about their background, personal interests, and opinions in general. Therefore, they got to know one another better, and they established a 'distance dialogue'. What is more, the kids also carried out collaborative work, for instance in joint story writing.

6.3.7 Projects about on-line education for teachers

In the last 5 years in Italy a lot of project for teachers' distance learning and collaboration has arose. Between them there are two projects at National level: Polaris project and Medea Project.

Polaris is a joint project between the Technical Instruction Division of the Italian Educational Ministry and the Institute for Educational Technology (ITD) of Italy's National Research Council (CNR). The project started in the 1996 and lasted two years. Its aim was to experiment on-line education for teacher training. About 60 teachers were involved in the project for the first year and 75 for the second year. Main goal of the project was to build a Community of Learners between all the participants in order to let them communicate and discuss not only with tutors but also with all the co-learners.

Medea is a project for teachers' distance learning about Environmental Education. It is carried out by the Institute for Educational Technology (ITD) of Italy's National Research Council (CNR) and funded by the Ministry of the Environment. The project started in the 1995 and it is still going on. During the course teachers have to develop a joint project about environmental Education, collaborating on-line with other teachers. The Software used is First Class, a computer conference system.

6.4 Conclusions

From paragraph 1 emerges that computers are more spread at the higher levels of school than at the elementary and junior levels. In contrast to this, most of the projects reported as best practices in paragraph 3 involve the lower levels. This data is not easy to be interpreted: where computers are most disseminated (higher levels), they are not used at their best; on the contrary, at the lower levels, where an inferior number of computers are located, often the projects reach a good quality. It is possible to explain this phenomenon as a consequence of the school structure, very rigid at a higher level and more flexible at a lower level. Another factor could the different attitude of the elementary and junior teachers. Elementary teachers may be more incline to implement innovative and research-based activities in their classroom than their colleagues from the higher levels. At the same time, schools at a higher level have better access to economic funding and this explains the bigger quantity of computers at that level.

It can be concluded that the theoretical development of CSCL is more advanced than the actual practices in the Italian schools. For some aspects, such as the collaboration and constructive dimension, the conceptual ideas are guiding the introduction of computers in schools. For other aspects (such as the community development and communication supported by computers), it seems that the theoretical development is not able to understand the problems and constrains of many schools settings. In any case, when looking at the progression of the numbers about ways of using computers in schools over the years, it can be said that in Italy the process of introducing computers in education in effective ways has started up. In fact, the Italian teachers know what collaboration and collaborative learning is (Talamo, 1985). Nevertheless, a certain resistance coming from the teachers slows down the introduction of computers as a basis for educational practice. Teachers tend to resist the changes, because perceived as "costly", in terms of time or cognitive and organisational efforts. In order to overcome teachers' resistance to changes, it is necessary to understand their reasons and seek solutions together with them. It can be said that in Italy there is a lack of this type of studies and researchers.

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7. CSCL in the Netherlands

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7.1 Implementation of ICT in Dutch education

What is the current state of CSCL in the Netherlands? This section presents the state of the art implementation of ICT in the Dutch schools to provide a context for the ITCOLE research. This will start with an overview of the technical side of the story, followed by the usage figures and concluded with an overview of theoretical perspectives and the available software for both primary and secondary education. The data are taken from the national evaluation survey of ICT in education. This survey is conducted every year by request of the Ministry of Education. The 2000 version of this survey is used for this chapter.

7.1.1 Primary education

<u>Technical data</u>
The number of pupils per computer is currently 12 in Dutch primary education. These computers can be divided in old and modern computers. One third are modern computers of Pentium quality. The remaining two third is from before the Pentium generation. According to the 2000 survey 66% of the schools are connected to Kennisnet (Knowledge Net). All primary schools should be connected by the end of 2001. Kennisnet is the initiative of the government to connect all school to a special intranet, which filters the Internet for school use. A special case is formed by the Amsterdam initiative to connect primary schools to the Internet. Schools are equipped with Intranets and thin clients (Sun Ray) at a rate of one workstation per 20 pupils. Along with the older PC's sometimes a ratio of 1:8 is realized.

<u>Usage data</u>
60% of the Dutch primary teachers use a computer daily. The classroom applications are mostly for drill and practice purposes and writing papers and reports. Also CD-ROM's and educational software are used, but to a lesser extent. Computers are mostly used for Dutch language, math and geography. The Dutch ten-year olds spend approximately 30 minutes per week behind a computer during school time and 8 times 30 minutes per week outside of school time. 92% percent of the pupils have computers at home. For the Amsterdam schools these figures are similar, but in comparison much more usage is made of the Web and of electronic communication. Every year thousands of pupils are involved in 'teleprojects', in which pupils of different Amsterdam schools communicate and collaborate around different subjects using the Dutch language. As part of a European project (CL-net) the University of Amsterdam introduced groupware (Web Knowledge Forum) to some of the schools with which more structured CSCL-experiments were realized. Also some international collaborations take place, either in the form of e-mail based projects, e.g. under the aegis of international school networks like the European Schools Project, or using Active Worlds for limited projects with Italian schools.

<u>Products</u>
There are a number of language and math applications for primary education on the market. However, those are independent applications that focus on the individual pupil and not on the collaboration between pupils. Educational publishers often produce these programmes as an add-on to integral methods within domains of subject matter. Kennisnet does have a number

of applications that are focused on collaboration through email and forum activities. Blackboard is Kennisnet's platform for creating communities of mainly teachers around topics of common interest.

7.1.2 Secondary education

<u>Technical data</u>
The number of pupils per computer is currently 13 in Dutch secondary education. 71% are modern computers, which means that they are of Pentium quality. The other 30% is from before the Pentium generation. According to the 2000 survey 92% of the schools is connected to the Internet. Almost all secondary schools work with intranets, and almost all schools have access to the Internet, via Kennisnet.

<u>Usage data</u>
Relatively few Dutch secondary education teachers, about 32%, use a computer in their lessons. They do use computers more often outside their teaching activities. The pupils do use computer both outside and inside the school. Their usage of computers at home for school activities is larger then their use of computers in school. Teachers are able to use computers, but are not very knowledgeable about the ways to use the computer for educational purposes within the classroom. They are using computers for instruction, practice, data processing, and testing. Most secondary schools have software for Dutch language, other languages, mathematics, computer science, geography, science, and technique. For other subjects there are only a few applications available in secondary schools.

More teachers than in primary education are involved in international teleprojects, but in all the percentage are still limited.

<u>Products</u>
Like for primary education, educational publishers have produced a range of educational software for secondary education devoted to different subjects. There are a few collaborative projects but again the emphasis lays on the individual use of ICT. More usage is made of simulation programs, and open-ended software like office suites, etc. Increasingly the Web is used as information resource.

7.2 Theoretical principles and models for CSCL in the Netherlands

In this section an overview is given of the state of the art of CSCL research in the Netherlands. Negotiation about interpretations is an aspect that most of the research projects include.

As in many countries the shift from traditional, objectivist education to different gradations of constructivist education has become visible in Dutch education. Not only the characteristics of the learning outcomes changed - learning outcomes should be durable, flexible, functional, meaningful, generalisable and application-oriented (Simons, Van der Linden, Duffy, 2000) - but education focuses also on new types of learning outcomes. Not 'knowing as much as possible' is the main starting point but skills of learning, thinking, collaboration and regulation. The next paragraph gives a brief overview of the major changes in secondary education that took place in the past ten years in order to provide context for the next paragraphs.

7.2.1 Innovation in secondary education

In secondary education the constructivist perspectives on learning have caused major changes in the way teachers should teach and learners should learn, but also in the contents of what learners should learn because of the developments in the society. Two extensive changes in the educational system were implemented in the 90's.

In 1993, the first three years of secondary education changed radically. Together the three years form one phase in secondary education under the name 'Basisvorming' (Basic Education). All pupils study a broad core curriculum, which is the same at every school, although the level varies depending on the type of school. Great care is taken not to teach subjects in isolation from each other. A lot of attention is also given to everyday situations. Pupils are expected to do a lot for themselves and are encouraged to ask themselves: what can I do with what I have learned? So the purpose of the 'Basisvorming' is to give every pupil the knowledge, skills and attitudes they need for their further school career. The focus is more concentrated on 'learning to learn', 'learning in concrete contexts' and 'learning by applying'. Pupils learn to do research, work collaboratively, and define their own criteria for assessment.

In 1998, the last years of secondary education on the highest two levels (the last two years within the HAVO, senior general secondary education and the last three years within VWO, pre-university education) went through a major change. Together these last years form the 'second phase'. The main change in HAVO and VWO is that pupils will no longer have so much freedom to choose their examination subjects. Instead, they have to choose one of four fixed subject combinations. This will ensure that pupils follow a coordinated study program and are better prepared for higher professional education ('hogeschool') or university. It may also help to reduce the number of pupils who leave higher education without qualifications. The four subject combinations are:

1. science and technology
2. science and health
3. economics and society
4. culture and society

All four subject combinations consist of a common core of subjects plus a number of specialized subjects and an optional component. The core subjects take up just under half the time spent on the course. The specialized subjects take up just over a third of the course. The rest of the time can be used to study other subjects offered by the school or to study a particular subject in more detail. This will increase pupils' chances of being able to move on to higher education. Another new feature of the HAVO and VWO systems is the emphasis on independent study: schools as 'places of study'. This does not mean a new kind of school school but a change in the supervising role of the teacher, which is designed to encourage pupils to do more work on their own. The last new concept introduced is the 'study load', which replaces the previous system of calculating courses in terms of teaching periods. The study load is the amount of time that most pupils need to cover all the material in a particular subject. This does not just include attending lessons at school but also preparing for them at home. Writing up projects, reading books, using a multimedia resource centre or library and taking part in school trips are also part of the study load. Pupils are expected to spend an average of 40 hours a week, 40 weeks a year, on their studies. This works out at around 1,600 hours a year. The study load for the second stage of HAVO is therefore 3,200 hours (spread over two years) while for VWO it is 4,800 hours (spread over three years).

So all in all the pupils are supposed to learn in the 'study house' more independently, active and collaboratively than before the change. The pupils become more responsible for their own learning process. Pupils work together with pupils from other schools, sometimes in other countries, to communicate, collect information, and discuss. Especially in the second phase of secondary education more and more e-learning platforms are used to let pupils work together as they have less lessons in class.

7.2.2 Future perspectives

In a document of Volman and Janssen (2001), two future scenarios are presented, from the perspectives of new roles and functions for teachers. In the first scenario 'the individualising of learning processes in well-conceived systems' is put central. In this scenario teachers will have to be empowered to have much more insight in the development of individual pupils. Pupils will have more clarity on meeting the expectations of the teacher and the mastering of subject matter, while the diversity in ways of learning and learning materials, and the possibility of distributed learning, is attractive and motivating. However, a separation of cognitive learning and social learning is seen as a main risk of this scenario. When focussing too much on tailor-made supply for individuals, the pedagogic function may become underexposed, thus leading to lack of attention for the social and moral learning experiences. In the second scenario the focus is on 'working in a learning community with technological tools'. Groups of pupils will work together on authentic problems in a problem-based or project-based way. The Internet is an important source of information but the pupils also explore literally outside the school. They learn by 'producing'. They build knowledge and acquire skills. Pupils do not have many tests anymore, but they demonstrate their knowledge and skills acquired in groups in their (partly electronic) portfolio. CSCL is used to support the pupils to collaborate, and to give each other feedback.

The scenarios were discussed and validated by an extensive forum of policy makers, members of the educational community and scientists. In general, the forum agreed to take the second scenario as starting point for the professional development of teachers and the renewal of education, but to include elements of the first scenario, albeit avoiding its anticipated negative side-effects. A further agenda for policy and research action will be derived.

Learning environment models

Quite some models were developed to improve the traditional didactical triangle with the teacher on top and the content and the learner as the base of the triangle (see Figure 2).

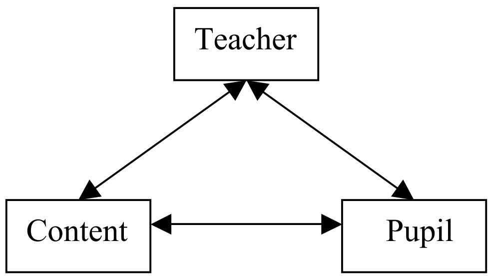

Figure 2. Traditional didactical triangle

The metaphor of the didactical triangle shows that the main interaction for the pupil is between the teacher and the pupil and between the content and the pupil (mostly by reading a book and doing tests on the content). Nowadays, we see that new metaphors and models emerge in which the learning environment has more actors, elements, and interaction processes. We show here two Dutch models that are a renewal of the traditional triangle. The first one is the Learning polyhedron. The metaphor was suggested by Van den Dool, Moonen and Kraan (1998). In Danau, Verbruggen and Sligte (1998) it was elaborated in more detail and dubbed ICT-rich Learner-centred Learning environment (Figure 3).

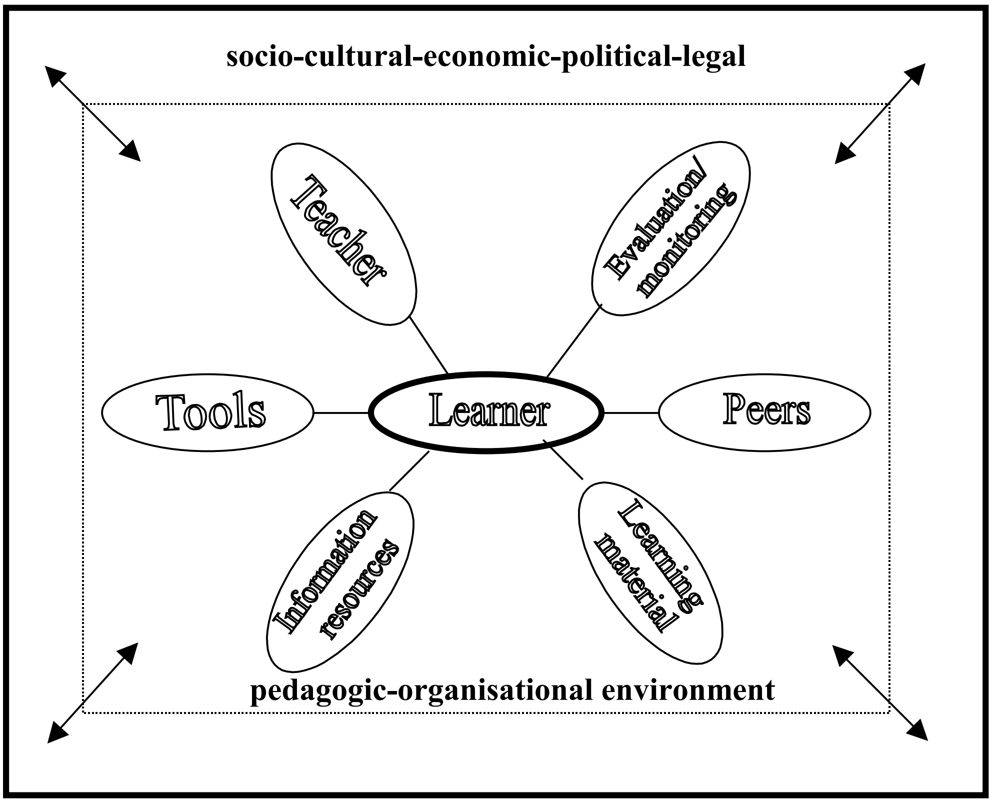

Figure 3. ICT-rich learner-centred learning environment (Danau, Verbruggen & Sligte, 1998)

The representation of the didactical polyhedron is characterised by a flexible networked structure in which ICT-tools and resources introduce new, and enrich old components within the learning environment. New pedagogic and didactic arrangements, in addition to the ones merely based on the instructivistic paradigm can be implemented. Firstly, in addition to the physically present teacher, other teachers or experts at a distance contribute to learning. The teacher him/herself can be physically or virtually present, either via e-mail, Intranet, or groupware. Certain educational software can fulfil a teaching role. *Fellow pupils* for collaboration and network-learning are introduced, not only within the classroom, but also in other rooms within school using Intranets, and in other schools, both in one's own region or country and abroad, via e-mail, web-based videoconferencing or groupware. *Subject matter* does not come in books alone, but in all kinds of multimedia and/or Web-based forms. ICT-mediated (self-)assessment tools broaden the *monitoring and evaluation* of learning, traditionally done by the teacher. Web- and CD-ROM based *information resources* complement the paper-based resources and a variety of new *tools* and media exist in addition to pen and paper.

The second model depicts the didactical square (Figure 4).

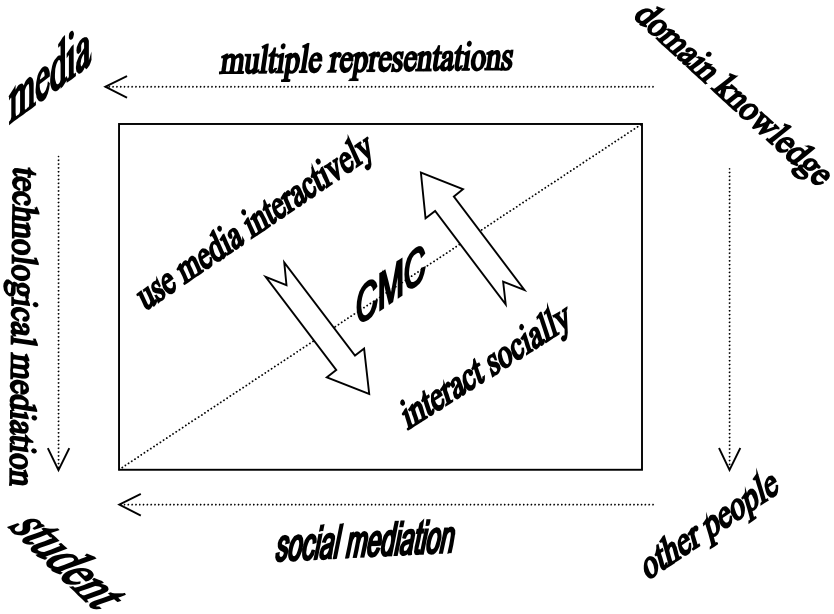

Figure 4. Didactical square (Kanselaar, De Jong, Andriessen & Goodyear, 2000)

In this model computer mediated communication (CMC) plays a central role to combine the advantages of social interaction (interpretative, meaning oriented) and electronic interaction (different representation forms – graphical, textual, dynamic – and automatic storage of the (inter)actions). Because of storage of the interactions, a 'group memory' is created, which is an advantage over oral communication. This CMC encompasses both the characteristics of the knowledge domain and the characteristics of the pupil. Still more research is needed about e.g. the mutual effects of regulation and co-ordination processes and the support arrangements in CSCL.

In addition to the increase of elements in the models, it also shows that ICT became an integrated element in the learning environment. In both models, collaboration is an important aspect of the learning process of the pupil, which is related to the new learning outcomes stated in the first paragraph. They are also related to the constructivist idea that learning is a social process and practice in which personal interpretations are negotiated (Heeren, 1996). The use of ICT for these negotiations makes it possible to not only collaborate in the physical classroom but also with other pupils and experts, nationally and internationally.

7.2.3 State of the art research

Every year the ORD-conference (Educational Research Days) takes place in the Netherlands. It is the main conference in which educational research is presented by Dutch and Flemish researchers, thus providing a good overview of the research work done. Two years ago the theme 'collaborative learning' (CL) was chosen for the conference. Striking was that, except for the contribution on the European project CL-Net, one of the conceptual predecessors of the present ITCOLE-project, the research articles related to CSCL focused only on higher education and not on primary or secondary education. At the same conference Veenman, Kenter and Post (1999) concluded that there is a growing interest for CL but that the ideas of CL are not applied in Dutch primary education. At the ORD conference of 2001 Veenman et al. came to the same conclusion for secondary education (Veenman, Van der Burg, and Koenders, 2001).

When looking at the articles of the proceedings of this year's conference, fortunately some more contributions can be found about CSCL research. Last year researchers from four different universities started with four research projects under the name 'Regulation and coordination processes in collaborative learning in different ICT-environments in secondary education'. The main research questions of this research project are: "In which ways do a) social coordination or shared regulation processes between learners, b) individual (meta-) cognitive self regulation processes and c) different characteristics of the environment and support in electronic learning environments, influence each other? How do different combinations of these three processes facilitate or restrain each other on individual, social and task level?"

The four projects have some characteristics in common. They all have a focus on interaction of coordination or regulation mechanisms in electronic learning environments. A second shared characteristic is that the environments used or developed for learning facilitate and support learning in a 'productive' manner, like learning in a simulation environment or when building a 'world' in which explanations of phenomena are (re)presented. This is related to the constructivist principle of 'creating knowledge' in contrast of the instructivist/objectivist principles. Two projects focus on discovery learning principles. They use different representations of mathematical models and aim to test the different influences they have on learning. A third project uses the aspects that lead to cognitive effects of Dillenbourg's CSCL theory (1999) and the principles of communities of learners of Brown et. al (1993). The fourth project is about communication and the model of 'grounding'. This model of grounding implies that 'good' communication between partners requires good development and maintenance of a common knowledge base. In all the four projects, an electronic discussion space is provided to support the collaborative learning process. The fourth characteristic they have in common is the target group: pupils from the second phase in secondary education of the two highest levels. Both the subjects are different in the projects, and the electronic environments used (SIMQUEST, Active Worlds, Knowledge Forum, Belvedère).

Related to the SIMQUEST project a PhD. project is in progress about the contribution of communication activities on the quality of the learning process and on the product of learning (Saab and Van Joolingen, 2001). Also in this research project collaborative and discovery learning have a central place. Saab focuses on the elaboration perspective instead of the co-construction perspective. This means that emphasis is on the type of interaction and the individual learning process.

Research of Veenman et al. (1999) looked at the views that primary education teachers have on collaborative learning (without the use of computers). Teachers see the power of CL in the development of the social competence of the pupils, the positive influence on self-esteem of the pupils, pupil's focus on tasks, and the attitude of pupils in relation to the subjects and school results. But the researchers see a difference in the way teachers bring CL into practice and the CL characteristics presented in scientific literature. An explanation for this can be that learning is still too much seen as an individual process.

Simons (1997) distinguished three types of collaboration processes: independent collaboration, learning together and self-learning teams. These types show an increase in responsibility for the learning functions, like preparing functions, execution functions, regulative functions, and affective functions (Boekaerts and Simons, 1993). Luttik and Erkens (1999) found that most of the collaboration processes in secondary education were 'independent collaboration'. Sometimes there are 'learning together' processes but 'self-learning' teams were very rare. Teachers see the opportunity to teach skills as the main advantage of CL, but bad work attitude and motivation of pupils, differences in levels in the group and dealing with the changed role of the teacher are seen as the disadvantages.

7.3 Overview of the main projects in the Netherlands

We have selected three innovative usages of CSCL in both primary and secondary education in the Netherlands. The first best practice is dealing with Active Worlds, the second with Knowledge Forum and the last best practice is about the use of email projects.

7.3.1 Active Worlds

This best practice describes the use of Active Worlds at a Dutch high school, the Haags Montessori Lyceum. Active Worlds is a powerful three-dimensional electronic learning environment, in which pupils can engage in constructive learning activities. The environment consists of three-dimensional spaces, called worlds. A wide variety of worlds from different educational institutions can be found in this Universe, called Eduverse (www.activeworlds.com/edu). Pupils can discover a world and even collaboratively build new components within a world. People take on the form of an avatar in these worlds. These animations can walk, fly, chat, and make gestures.

The aim of this project is to create a powerful learning environment where pupils can work on assignments that go beyond one subject in both national and international collaboration. The pupils are of all levels within the Dutch secondary education, their age ranges between 12-18. They can be divided in two groups: one group that are building specialist, they train the other pupils and serve as a help desk for the collaborating pupils and teachers, while the other group uses Active Worlds to execute assignments in collaboration with pupils at other Dutch schools and internationally. At this moment, three teachers are creating tasks and assignments for active worlds, but slowly more teachers are involved. Collaboration with two other Dutch high schools is slowly taking form and next school year assignments will we executed in collaboration with these schools.

The current projects focus on art, history, and science. The subjects used are the artist Bacon, political cartoons, and science applets. The task for Arts consisted of building a museum. The city museum of The Hague was showing an exhibition of the artist Bacon. The pupils analysed his work and built a virtual museum where their own work, created in the style of Bacon, was shown in addition to the work of the real artist. The task for history contained the analysis of historic cartoons of different nations in collaboration with pupils of these countries. For example, the Dutch pupils received a Russian cartoon and asked the Russian pupils questions about the cartoon in order to understand it and write an analysis about it. The Russian pupils did the same with Dutch cartoons. In the science assignment the pupils collected applets all over the Internet and placed them together in the physics building ordered by subject.

The different projects can be found in the worlds “edubacon”, “cyberart” and “eduHML” of the education universe www.activeworlds.com/edu.

The results of the project show an increase in enthusiasm from the side of pupils compared to traditional education. They found it motivating to work in this environment and they produce high quality results. Collaboration in this environment is supported by the sense of reality created in the three-dimensional world. More formal results about the added value of 3-D worlds on the learning process will become available through a 4-year research of the Universities of Amsterdam and Nijmegen, in collaboration with the HML.

In order to use active worlds in education good assignments need to be created to support pupils. Teachers are initially reluctant of using a 3-D environment, however once started and seeing the enthusiastic pupils this initial hesitation disappears.

7.3.2 Web Knowledge Forum

This best practice will describe the use of Web Knowledge Forum in Dutch secondary education. It is an abstract from Van der Meijden & Simons (2000).

Web Knowledge Forum is a software program that has been developed by the Ontario Institute for Studies in Education at the University of Toronto (OISE). It is a network system that provides support for collaborative learning and inquiry. At the centre of the software is a communal database, which can be filled with contributions or “notes”, by pupils and their teachers. Pupils enter their own notes, and/or build on and react to each other’s notes in order to find the answer to a question or to solve a problem. All notes are saved in the database and are available for all pupils who have access to it, within the class, in different classes, or in different schools. Because the software’s architecture is open and content free, it can be used in all areas of the curriculum. Moreover, it can be used outside the school because pupils and teachers can log in from other computers connected to the Internet.

The study was carried out in a secondary school in the Netherlands, The Raayland College in Venray. The Raayland is a school that includes all types of secondary education: Gymnasium, pre-university education (VWO), senior secondary education (HAVO), junior secondary education (MAVO) and preparatory vocational education (VBO). The class levels involved in this project included: 1 Gymnasium, 3 pre-university education (VWO) and 2 senior secondary education (HAVO), third and fourth grade. Teachers were recruited based on their willingness to participate in this study and the type of courses they were teaching. A total of five teachers were involved in this project. During the project there was support from researchers from the University of Nijmegen. The researchers were present during class activities.

The project content areas were biology, history and physics. For both biology and history the pupils did two courses, for physics there was only one course. The subjects have been: healthcare, ecology, discrimination, civics and planets. Each course consisted of six lessons. The model of progressive inquiry was used as leading pedagogical model.

A typical series of lessons is described below.

Lesson 1:	Instruction in Web Knowledge Forum.
Lesson 2:	Activating advanced knowledge in a brainstorm session in groups working on the same subject matter. Pupils create their own research questions and enter them into the database.
Lesson 3-5:	Pupil pairs try to find the answers to their research questions, gather information about their questions in the library or from the Internet, and put their knowledge into the database. They comment on information of others in the database and ask questions if they want to have something clarified. They construct new research questions.
Lesson 6:	All pupil pairs make a resume of the knowledge they have acquired and make comments on the resumes of other pupil pairs.

The results of the project indicated that the pupils applied many activities in the database. They made a lot of contributions, searched for much information, copied a lot from the Internet. They made hardly any content related references to the contributions of other participants in the database (linking information). They did not look back to information already present in the database, and they hardly applied any other regulative activity. They did not check if they had found the answers to their earlier formulated research questions. The model of progressive inquiry had not been elaborated effectively, only the first 2 steps had been followed. No refinement of questions took place and no other research questions were formulated. Conclusions or summaries that were formulated contained only information that was gathered by the group itself.

The level of teachers' activity was very low in all six databases of notes. One teacher deleted three notes, because they were offending other persons. In some databases the teacher had made no contribution at all. If a teacher made a contribution, it was mostly a regulative one, like "check information by others" or "what kind of questions would you like to ask the administrator?" The reason for this absence of activity in the database may have been in the fact that the model of progressive inquiry was not elaborated thoroughly enough. It appears that secondary school children (grade 3 and 4) were not able to apply the model of progressive inquiry by their own. They need the cognitive and regulative guidance from the teacher.

7.3.3 Email projects

The first three projects are email projects based on the idea of letting pupils get acquainted with each other through email communication. The description of these three projects is based on the web site of CIAO (Computers In Amsterdam education). CIAO aims to innovate and improve the teaching and learning process in primary schools by bringing information technology into the main educational program and making it accessible and attractive to both teachers and pupils. In the recent projects, pupils worked together in their own classroom as well as communicated with pupils from another school about their work.

The bear project

This bear project is one of the CIAO email projects for pupils of around 7-10 years old, for the domain language (writing). It is based on the Teddy Bear project frequently undertaken within the I*EARN-network. The project has several objectives:

- Stimulation of communication between children
- Practice of written language skills
- Learn to write a letter or report
- Learn to express feelings and interests
- Learn to interact with each other, learn about different cultures, social circumstances, and living conditions.

The project starts as follows. The teacher and some of the pupils go out to buy a bear together. This bear will stay for a certain period with children of another school. Therefore the bear has a suitcase with small items that the pupils chose to give him (e.g. some honey, a little pillow, socks). Also the pupils can introduce the bear by making drawings and texts for the other school, like the example below about the bear Max.

When the bear goes to the other school, the pupils of that school will take care of him. He stays at a different home of one pupil every night. The next morning this pupil writes the other school an email to tell about the adventures of the bear. For example, the bear can be taken to a ballet lesson of a pupil or had dinner with the whole family. The children learn to write from the perspective of the bear, what he sees and experiences. Information in Dutch available at: http://www.edu.amsterdam.nl.

Your future in Amsterdam project

This email project is also part of the CIAO project. It is for pupils at the last class of primary education (11-12 years old). The domain is Dutch language. It focuses on writing skills, spelling, learn to write an email message. From a social emotional perspective, the project focuses on learn to cooperate, to take initiatives, to stick to agreements, give positive feedback. The pupils orientate on living, working, and free time in the future. The project consists of three lessons:

Lesson 1: *How and where do you live in 2015?* Topics can be: living alone, together, having children, which city/village, description of the house.

Lesson 2: *What is your profession in 2015?* Topics can be: which schools did you go to before getting that job? What are nice aspects of this profession? How does your workplace look like? Do you want to do this your whole life?

Lesson 3: *What do you do in your free time in 2015?* Topics can be: do you do sports, collect things, what do you do during your holidays, what do you like to do alone, and what with friends?

Information in Dutch available at: http://www.edu.amsterdam.nl.

The Image of the Other

The Image of the Other is a (international) teleproject for English as a second language for pupils of 10-15 years old. Also a German version and a French version exist of this project: "L'image des Autres", or "Das Bild der Anderen".

These teleprojects have been used by 80 different partnerships in 2000 only. Over the past ten years tens of thousands of pupils were involved. The necessary educational, organisational and technological support for these projects is organised within the European Schools Project, a network of schools and other educational institutions in many countries of Europe and beyond.

In this teleproject, pupils from two different countries write to each other in English, which is their second language. They communicate via email around certain themes like 'my home', 'my school', 'my hobbies' etc. Via this email communication, the pupils can build an image of each other. In the last email, the pupils write everything they know about the other pupil as a check of what they understood of the other. The central point is that pupils practice their written communication skills in a second language and come in contact with another country, another culture and other habits.

Information in English available at: http://www.esp.educ.uva.nl/Image-UK.

Fly with email

Fly with email was a project of the Educational Academy Edith Stein/OCT, The Netherlands Institute for Curriculum Development (SLO) and the faculty of Educational Science and Technology of the University of Twente. They developed a series of lessons about Flying with e-mail that are tested in fourteen primary schools. They did observations, interviews and collected data via questionnaires which resulted in a website with information for teachers and a publication about the use of email in the classroom.
The project is meant for pupils of 10-12 years old and includes several domains: handicrafts, information technology, and communication skills. The task for the pupils is to make 'something that can fly for some time'. This task is quite complex and open. The pupils do not oversee immediately all the problems they have to solve. There are two different collaboration parts in the task. Four pupils of the same class work together to make the object but the groups also communicate via email with a group of another school to discuss the design and development issues ('do you think a plastic bag is the right material for the wings?'). For difficult questions, they can email a plane expert. At the end of the project the pupils have made an object that can fly for a little while. The pupils learn to work together, communicate via email and go through a problem solving process.

Information is available in Dutch about the use of email in such a project at http://to-www.edte.utwente.nl/e-mail_in_klas/kid/ and in Boersma & al. (1998).

7.4 Conclusions

In general, we can conclude that there is a fair amount of usage of ICT in Dutch education. Approximately a ratio of one computer on 13 pupils is realised and a respectable number of schools is connected to the Internet. What is striking, however, is the difference between primary and secondary education. Primary education takes a strong lead in the use of ICT, whereas secondary education is lagging behind in these developments. In response to these developments, the national boards of primary and secondary education, in collaboration with the Dutch ministry of Education, have created a foundation that focuses on the use of ICT in education, with a distinct mission of stimulating secondary education.

Review of the research shows that CSCL is not commonly used in primary and secondary education in the Netherlands. Research themes in the field of CSCL are: regulation and co-ordination processes in different learning environments, and the contribution of communication activities on the learning process.

Results of the Dutch studies in implementing Knowledge Forum and progressive inquiry into school indicated that pupils need a great deal of cognitive and regulative guidance in order to participate in higher levels of inquiry. Pupils need help in discovering the value of forming one's own theories and in working out research questions by their own. Pupils cannot be expected to discover these practices by themselves. This implicates that more efforts should be invested in teachers who participate in CSCL-research using the model of progressive inquiry.

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8. Conclusions - pedagogical guidelines for designing ITCOLE CSCL

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8.1 The state of the art of ICT in European Education

According to this review there are huge differences in how ICT has been implemented in different European countries. The emphasis from the government and other authorities varies a lot between countries. However, even though the countries have started to build the information society at different time, that is, equipping schools with computers and networks, it seems that secondary level students have quite good accessibility to computers in all four countries. The difference between primary and secondary level was acknowledged in each country. Further, it seems that during the next few years there will be substantial investment in each country, on governmental or private level, to equip all the schools with computers and networks. What also seem to be common are the constraints: lack of trained personnel to give adequate support for teachers and lack of guidance to use ICT in a pedagogically meaningful way. Few computer labs are still used by too many students and teachers, and therefore they are not providing possibilities to use ICT in versatile way or to create meaningful learning environments. Teachers are mostly using basic applications, such as word processing, and students are using educational programs or multimedia products designed for individual learning.

All the four countries have employed the same basic theoretical framework (constructivism, sociocultural/situative view) to create CSCL practices and to conduct research within this area. However, in each country the development work is concentrated on in some special domains, methodologies, or theoretical approaches. In Greece, the researchers in the field of CSCL have emphasized the importance of research on conceptual change, especially in mathematics and science education. In addition to pre-post –settings, the Greek researchers have developed methods for analysing students' interaction. In Finland, special focus has been on developing the pedagogical model of progressive inquiry, on investigating cognitive and motivational dimensions of CSCL in different school levels, and on developing qualitative content analysis methods as well as analysis based on video data. The Italian researchers have been interested especially in the features of community development and different forms of collaboration. The latter focus has inspired them also to develop the discourse analysis technique further. In the Netherlands the emphasis, especially in secondary education, has been on authentic learner-centered learning contexts, and in how students 'learn to learn' within these new learning conditions, including shared regulation processes between learners as well as individual (meta)cognitive self-regulation processes.

The overview includes descriptions of innovative and theoretically well-argued projects. The variety of different tools, from simple e-mail systems to more complex three-dimensional learning environments, has been applied in different school levels, from primary level to university level, within different domains. However, the outlines do not focus only on tools, but describes also interesting and significant research designs and results. Some projects have also accomplished nationwide and international collaboration in a successful way.

8.2 Guidelines for developing CSCL

Conclusions of the main projects carried out in the participating countries underline also some profound constraints and challenges in developing educational practices with collaborative technologies. It appears that practices of CSCL have not yet been scaled up in Europe. Although the scientific community has considered the principles of CSCL highly promising for the development of future learning environments, this is not yet the case among practicing teachers. It is certainly partly due to the novelty of the CSCL ideas in schools but it also indicates that the theoretical and practical principles of CSCL are still too immature to be widely applied in practical educational reforms. There is a need for theoretically well-grounded development of CSCL practices and tools, which are adequately embedded in practical educational context. The present review highlights the importance of carefully analysing the presuppositions in applying technology-based instructional innovations in practical classroom situations. The guidelines for developing ITCOLE CSCL will be discussed in the following chapters.

8.2.1 From Technical to Systemic Approach on CSCL

The present review has shown that there are substantial pedagogical, cultural and epistemological challenges of computer-supported collaborative learning (CSCL). As a consequence, the CSCL community is currently re-assessing foundations of the field. Many early approaches to CSCL were over-optimistic and "technocentric" in nature. These approaches relied on an ill-founded assumption that CSCL is mainly about design of technology, and that by providing educational institutions with well-conceived and reliable technical tools, the most important aim of CSCL—improving the quality of education – might be attained. In effect, they assumed that revision of pedagogy was not a crucial issue in insuring success. Yet another group of approaches was rather successful for reasons that have become increasingly apparent: Designers of these systems (e.g., CSILE, BELDEVERE, CO-VIS) were themselves pedagogical experts and able to create systems that focused on critical aspects of learning (e.g., externalization, learning by writing, making thinking visible, collaborative problem solving). Further, the researchers themselves were often present in the classrooms being studied and offered high quality support of a rather uncommon type. As a consequence, the learning communities in question got both technical and pedagogical support and relied on a local culture that supported collaborative learning. Yet, the essential role of such high-level support, in both qualitative and quantitative terms, appeared to be sometimes under-appreciated, or perhaps not seen as differing in critical ways from support that might be commonly available.

In moving from specially supported classrooms to normal classes, whole school and larger educational systems, a wide variety of further pedagogical problems thus emerge. Teachers and students may not have computers; they may not have appropriate skills in using them; they are not able to solve technical disturbances or bugs; and so on. In other words, there appear problems in implementation and pedagogy both stemming from assumptions about technology and about teacher and support capabilities. Our review of the use of CSCL in several European countries reveals these kind of constraints and challenges, and we propose that the arguments presented are most important for enhancing the quality of education through CSCL. In order to genuinely improve education, we should not market uncritical success stories or technology fetishism but empirically and theoretically sound research on actual changes that are taking place in educational institutions while introducing network technologies and collaborative environments.

After studying how educational practices have been restructured by means of CSCL across the last five years, we have learned to understand that educational change is very hard to bring about (Lipponen, 1999; in press; Paavola, Lipponen & Hakkarainen, in press). Although CSCL experiments usually improve the quality of learning and lead to teachers' professional development, it is most challenging to actually change prevailing educational culture. Pedagogical and cultural changes in cases of institutions and individual agents (e.g., teachers, students, employees and their communities) are very hard to bring about and are likely to take a long time. It is a systemic challenge that has simultaneously to be met by creating several infrastructures of change:

- *Technical Infrastructure*: Teachers, students, or other participants need to have an access to new technology in their everyday working environment as well as sufficient ICT skills. It often takes a long time to learn to use new technology in a flexible way and integrate it with one's own activity.

- *Pedagogical Infrastructure*: There has to be practical and workable pedagogical models that help to find meaningful ways of using new technology for solving problems, collaborating, building knowledge and networking with external communities. Progressive Inquiry has been developed as a pedagogical model for helping teachers and students to structure and concretise knowledge-building practices in schools with the support of collaborative technology.

- *Social Infrastructure*: New technology should be an integrated aspect of core educational processes rather than a separate activity. It is essential that building of a new culture of collaborative learning and knowledge building be supported by the content of curriculum, structure and organization of courses and activities as well as assessment practices. It is important to get the whole teacher community to engage in the professional development, have parents closely involved, and get support from the local community.

- *Epistemological Infrastructure*: Teachers, students, and other participants need to develop epistemological awareness of different categories of knowledge and processes of inquiry in order to be able appreciate the value of pursuing questions or explanations and engaging in deepening inquiry.

Our review reveals that in many cases some of these conditions are missing. Teachers and students may not have access to new technology, or it may not be intensively used. If technology is used, it sometimes supports less advanced practices (transmitting and copying information) rather than building of a new culture of inquiry. If a culture of CSCL is emerging, it is likely to happen only in the context of special projects supported by researchers, rather than as a good practice, which is part of a new culture of schooling.

This critical orientation was already a part of our project proposal. We stated that technical tools as such are not sufficient to promote actual pedagogical change at school. The problem is that technical tools do not themselves provide teachers with adequate models of pedagogically meaningful ways of using them in various learning situations. Consequently, the new technology is often used as a new means to attain old pedagogical goals. Therefore, it is important to try to further crystallise the pedagogical models of collaborative learning and knowledge building. This is a necessary condition for guiding both software development and teachers' practical instructional problem solving.

We are positive that, if wisely used, new technology will have a revolutionary impact on the culture of learning and instruction. This requires, nevertheless, a long-term commitment to develop and test new educational practices in a close collaboration between teachers, pedagogical researchers, and software developers. New sustainable pedagogical solutions emerge in the interaction of practitioners and researchers rather than be there to begin with.

The review is based on an idea that the design of ITCOLE software should be embedded in practical pedagogical models and ideals that help schools, teachers, and students to find new innovative ways of learning and instructing. Accordingly, an important aspect of the present project, in addition to software development, is a concrete implementation and operationalisation of what is already known about the theories of CSCL and knowledge building. All participants of the project need to work for integrating pedagogical and technological aspects of ITCOLE project into a mutually supportive whole.

8.2.2 Principles for Designing CSCL Environments

The ITCOLE project has very ambitious pedagogical goals. The project aims at developing a learning environment that facilitates new practices of interaction between students, between students and teachers, and new innovative ways of studying as well as new organizational practices at school. The objective of the project is to facilitate new skills of collaborative problem solving and knowledge building. Further, by providing an environment for student-centered and self-regulated inquiry learning, the project also fosters learning of higher-level cognitive skills, such as self-monitoring, meta-cognition, and intrinsic motivation building. Moreover, we aim at overcoming the limitations of virtual learning environments by providing tools for community and team building that help students to do social bonding and create sense of belonging.

The ITCOLE software is a pedagogically sophisticated learning environment that supports students' joint efforts to build knowledge together, whether they are primary, secondary, or older students. The system will be designed to provide tools to facilitate the overall development of the students' skills of collaborating, engaging in various networked activities, solving increasingly complex problems in different domains of knowledge, and working productively with knowledge. The system will also support interaction between students and teachers or students and experts, e.g., between school projects, and sharing of experiences or joint production of course material. The central metaphor of the CSCL system is that of shared electronic workspaces, which students and teachers use for collaboration.

Technical usability

The ITCOLE software is intended to be distributed widely across schools and educational institutions. Therefore, it is essential that the software has a sufficient level of technical usability, i.e., it is inexpensive to use and maintain, easy to install, run on local servers, and yet be versatile enough to provide comprehensive collaborative learning facilities for very large numbers of users across Europe. This is especially important because many schools do not have adequate technical infrastructure or sophisticated technical support that would help to keep the system running.

Designing for flexibility and modularity

The present review indicated that there are a variety of pedagogical cultures and practices in the participating countries. In order to answer these various pedagogical needs, it is important that the design of ITCOLE software represents flexibility and modularity mentioned in the project proposal. The proposal states that the functionality and the interface of the system will be derived from pedagogical considerations and can be adapted to the different school environments and contexts as well as used in conjunction with other pieces of software.

It follows that even if the ITCOLE software has to rely on pedagogically coherent ideas, the system and its implementation has to be flexible enough to be adapted to various national pedagogical cultures and different educational contexts. This may be implemented by creating a modular learning environment so that the users are able to selects what modules they are using in the context of each project. Further, it is essential that the central functions of the system can be tailored for specific pedagogical purposes. This concerns, for instance, that the category of inquiry-labels used in the system should be fully editable by users, just like is case in Knowledge Forum. This can be called *pedagogical usability*, i.e., correspondence between the system’s design and the educational environment, situation, and context in which it will be used. From the modularity principle it follows that information produced to the ITCOLE system should be able to transfer to other CSCL environments and productivity tools.

Facilitating knowledge building rather than providing a discussion forum

An essential aspect of a CSCL environment is to provide models and tools that help the participants share their knowledge and competence, and store knowledge and experiences of individual teachers and students, and their projects in order to create a collective memory.

We need shared spaces for representing shared problems, working theories, new information, and discourse interaction between the students. It is important that the ITCOLE environment does not only provide an environment for discussion, but supports knowledge-building inquiry as well. Structuring the discussion in terms of key problems and key ideas is one way of facilitating knowledge building. It is essential that the users focus on advancing ideas, rather than such matters as who is creating them or whose ideas have been picked up for further elaboration. This does not, however, mean that there would not be agency; it is important both to recognize individual efforts as well as to ensure that each student is participating with a sufficient intensity. Consequently, the discussion forum should be organised in a way that allows the participants to identify key ideas, to take them for further elaboration, and build on them. Structuring students' contributions by using category of inquiry labels may further support the knowledge advancement.

Discussion forum should not only support linearly advancing discussions, but should also facilitate in-depth inquiry that builds on other discussion as rise above formerly presented ideas. This means that there has to be functions that support making of synthesis of ideas and thoughts produced. The system could be designed to facilitate knowledge synthesis and creation by allowing one to take a whole discussion as an object on inquiry (take a copy of it) and to create a new meta-level note by building on that discussion. For instance, Knowledge Forum and Sonera Learning Experience have this kind of function.

In terms of software design, fostering of knowledge building entails that the system allows and encourages the users to work for developing shared digital artefacts (Jam Session) in addition to engaging in knowledge-building discussions. Tools for knowledge sharing and building should support creation of longer documents through commenting and version management. An important aspect of building the ITCOLE environments should be to provide tools that support collaborative designing and elaboration of digital artefacts. Increasingly important would also be to create tools and practices for constructing dynamic case descriptions.

Knowledge Management Problem

Designing of the knowledge creation tools may not only help to advance knowledge but it should also help to better manage the knowledge produced to a learning environment's database. A relatively large number of messages make it difficult to follow the discussion and get an overview of issues being discussed. When a database involves certain number of main problems, discussion threads, and individual entries, it becomes difficult to get a coherent picture of the database, various ideas, and their advancement. The challenge of knowledge management is to provide tools that allow creating a coherent view of what is going on in the database during intensive and possibly long-standing inquiry processes.

The fact that discussions are organised around ideas provide significant help, but an intensive discussion – possibly tens of steps deep – is rather hard to follow. It would have been very hard to participate without being closely involved from the very beginning. In order to solve this problem, it is necessary to develop tools that would help to organise the Knowledge Building Discussion messages.

It is essential to create tools that allow visualization of key ideas and key problems as well as hot areas of discussion. In creating the visualization, it is more important to emphasize ideas rather than relative contributions of the participants. It might be possible to apply methods of neural networks for visually organizing the discussions.

Scaffolding Progressive Inquiry

Using same kind of Category-of-Inquiry labels that Future Learning Environment was relying on should support inquiry process also within the ITCOLE environment. It means that users' participation is structured by asking them to label their messages according to a category of inquiry (e.g., Problem, Explanation) that it represents. These kinds of categories are assumed, if properly used, to *scaffold* the participants' inquiry processes and help them to engage in higher-level cognitive processes than would be otherwise possible for them. It is not necessary, for instance, to have former experience and knowledge of different aspects of inquiry to participate in corresponding process (question generation) supported by the inquiry categories. The meta-knowledge of inquiry processes is, in a sense, embedded in the learning environment in the form of the inquiry categories.

In order to use category of inquiry labels meaningfully to scaffold CSCL processes you need to have a theory of what is relevant, what is not, and this theory should be grounded on pedagogical practices. This theory is more about learning, knowledge building, critical thinking, or inquiry rather than only about designing CSCL or KB environments. There could be several series of thinking types representing these different cognitive practices (learning subject-matter knowledge, building knowledge together, engaging in critical discussion). It is, further, important to have coherent sets of inquiry categories rather than only individual categories. One should be able to say about each category why it is proposed, what aspects of the users activity it is related to, how does it relate to the other thinking types and how it should be considered rather than something else.

Optimally, the ITCOLE software should have fully editable inquiry categories that could be tailored for different pedagogical contexts. There should, further, be several sets of inquiry categories designed for supporting different types of activities, such as knowledge-building inquiry, argumentation, and fieldwork or learning subject-matter knowledge. Minimally, the system to be designed should involve thinking types to support Progressive Inquiry model that is the general pedagogical model embedded in the ITCOLE knowledge-building environment. These kinds of inquiry categories were designed and experimented within the context of FLE project. While designing the new categories, it should be relied on this earlier body of research. In FLE2 the following categories of inquiry were used: Problem, My Working Theory, Deepening Knowledge, Comment, Meta-comment, Summary and Help). In designing the ITCOLE software, we need to consider whether there is a pedagogical need to remove or add thinking types or change them somehow.

Muukkonen and her colleagues (1999) summarized in a research paper their experiences of the inquiry scaffolds in FLE: "The students were asked to categorize their posting to the database by using a set of cognitive scaffolds. However, the content analysis indicated that the students' productions often did not correspond with the scaffold they chose. The students showed a bias for selecting a Category of Inquiry that was very neutral, mostly Comment. Furthermore, their productions represented several categories, such as problems, working theories and deepening scientific explanations, simultaneously." In one of the courses, studied by Lakkala & al., 2001, students' used the thinking type "Comment" in over 50% of their postings. Students used that thinking type almost every time when the posting was a reply to another note in the KB. The other thinking types were mostly used only when the students were processing their own inquiry; maybe they felt that the "comment" type was suitable to situations where they contributed to somebody else's inquiry. It follows that the category-of-inquiry label "Comment" should be removed.

We have also analysed more closely the content of the FLE postings by segmenting all the message text into separate ideas. One posting or message usually included many ideas. We used following categories for labelling the individual ideas: Problem, Own explanation, Scientific Explanation, Quotes Participant and Metacomment. The aim of the analysis was to study how the progressive inquiry elements were present in students' knowledge productions. According to the analysis, university students had, for instance, quite a lot skilful "metacommenting" in their postings, although they did not use that thinking type in their notes as much as tutors. One aim in progressive inquiry is to teach students to evaluate their inquiry process, but the word "Metacomment" is evidently difficult to understand. We should find a more ordinary concept that means the same ("Evaluation of the process" etc.).

Most intriguing in one course, analysed by Lakkala & al. (2001), was that both the students and the tutors had *very* little scientific explanations in their postings, although one basic idea in progressive inquiry is that students learn to deepen their original explanations with scientific knowledge from information resources. It does not, however, follow that we should delete this kind of category of inquiry scaffold. On the contrary, we should search for, explore, and test scaffolds that promote the revision of original own explanations towards more scientific explanations.

In addition, many analyses indicated that the students' productions did not often correspond the scaffolding they chose. Their productions, rather, represented several categories, such as problems, working theories and deepening information, simultaneously. There appeared be two reasons behind this phenomenon. First, the students were not guided to use the scaffolds effectively enough; they did not have, for instance, joint sessions of using FLE. Second, it is possible that it is not natural for the students to partition their posting in a way that would correspond the scaffolds. Therefore, it would be important to further develop the functioning of scaffolds, and allow students to mark or sign the categories of inquiry within a message.

It is important to remember, however, that the effect of inquiry categories depends on whether teacher and students understand what those are all about as well as deliberately focus on structuring their activities accordingly. In terms of the use of the scaffolds provided by the FLE2 interface, a thematic analysis of the discussions revealed that tutor's "just-in-time" participation could have significantly changed this pattern, judging from the evaluations and reflections on own experience produced by the students. An implication for further development of ITCOLE system is that the participation of a tutor into the discussion is recommended, at least for courses with new users, until a pattern of interaction is established which explores all scaffolds provided by the environment. It is essential to provide the users guidance and support in using the scaffolds appropriately. This entails building of an appropriate pedagogical and epistemological infrastructure.

It appears that if the thinking types have been difficult to understand, there might be at least three reasons for that: 1) The inquiry approach is a new way of learning and working, and, therefore, it is difficult for newcomers to use the categories of inquiry. This problem cannot be solved by making the elements of the process too simple, but to help students to better understand the elements and the higher-level learning processes; 2) The categories of inquiry may not be suitable for supporting inquiry processes of very young students. This domain is not very well known and there appears to be a need for further pedagogical and theoretical work to develop new scaffolds. It would be important to explore and test some alternatives in the ITCOLE project; 3) The concepts or terms chosen to represent the categories of inquiry may be too abstract and theoretical. It is important to select expressions that are easy to understand, but still represent the core ideas of progressive inquiry.

On the basis of above presented considerations, we propose that the following thinking types would be used in a pilot version of ITCOLE software. It is also important to carry out studies in which different ways of categorizing and structuring inquiry are explored and analysed in details.

Problem	- My problem (it could be a group's joint problem)
Working Theory	- My Explanation
Deepening Knowledge	- New Information
	- or (Scientific knowledge/My investigation (reveals…)
Comment (Comment)	- Disregarded

Metacomment	- Evaluation of the Process (How-we-are-doing)
Summary	- My summary, My synthesis, Drawing things together

These are the same Categories of Inquiry as in FLE2, but translated to more easily understood format. They are based on the theoretical work that has been done in developing the Progressive Inquiry model.

A solution according to which users define the category of inquiry before writing the note, or actually, when they initiate a reply appears to be meaningful. A more structured way of using these categories can provide better results than letting students to decide whether they use a category of inquiry or not.

The Role of Tutoring in Progressive Inquiry

A series of studies carried out by the present investigators indicate that active engagement of the tutor is an important condition for facilitating progressive inquiry. In order to make it easier for a tutor to participate, the learning environment would need to be equipped with Tutor's Tools that would make it easy to print the students' productions and summarize advancements of inquiry. If each production has to be printed separately, it is most time consuming to try to review the content of the whole database. It is important to create tools that will help to provide summaries of discussions and each student's contribution during a project, and, thereby, help a tutor to get an overview of what is going on in the database.

It should be closely considered how much the scaffolds and tools embedded in the system support students' inquiry, and what aspects and phases in the knowledge building process need human tutoring and scaffolding. In addition, synchronous tools may provide important new possibilities for situated and dynamic guidance that would not be possible in asynchronous systems alone. Based on earlier research, we should develop concrete models and guidelines of teacher's various roles - as a tutor and as an expert model - and ways of contributing to students' collaborative knowledge-building inquiry. We need guidelines for both face-to-face classroom situations and for virtual tutoring and distance learning contexts.

Building Pedagogical Infrastructure

As stated above, knowledge building is only partially a software design problem, it is also a matter of designing appropriate pedagogical and epistemological infrastructure as well. Investigations concerning the extent and relative proportion of ideas representing different categories of inquiry indicate often that substantial pedagogical support may be needed to elicit in-depth inquiry. There are often considerable differences between students in the intensity of their participation. In order to introduce students to the model of progressive inquiry, it is important to have joint sessions of working with ITCOLE software, not just network projects and individual participation at distance (home).

In order to participate intensively in virtual learning environments, the students apparently need strong community support that would guide and challenge them to participate. Intensive participation appears to require deliberate efforts to build the students' community. Joint working with the environment would help the students to adopt the progressive inquiry model, and learn to direct their knowledge building process. The community support has to be provided both by the software environment and the actual face-to-face community.

Developing a Culture of In-Depth Inquiry

Experiences of FLE, further, indicate that the students are often relying too much on information provided by instructors or tutors, rather than engaging themselves in deepening inquiry. The information obtained from books, articles and study materials introduced as course material often play a minor role in the explanations produced by the students. Active participation by teacher or tutor may enhance the integration of scientific information into such a discussion.

In the background of this problem may be a general design of the curriculum. Especially in elementary but also in secondary level education, the curriculum is often “a mile wide, but only an inch deep”. In other words, so many things have to be skimmed through that teachers and students do not have an opportunity to engage in studying issues interesting to them in depth. In order to facilitate deeper inquiry, it would be important to focus on key ideas and organizing principles rather than go through a large number of issues at the surface level. In order to facilitate progressive inquiry, it may be necessary to change the structure of curriculum in a way that allows students and teacher to organize larger in-depth study projects that may integrate several subject domains.

Even if the cultural and curricular issues, which are external to ITCOLE software’s design, appear to be crucial for solving the problems of the lack of in-depth inquiry, it is essential to explore also the different ways of organizing students activities within ITCOLE environments so as to facilitate deepening inquiry. Are there good ways to make subject-matter knowledge available for the students in a way that would encourage deep thinking? How could knowledge-building processes be structured to encourage cognitive commitment to pursue one’s inquiry in depth?

Providing tools for structuring and coordinating activity

While trusting students to engage in more intensive self-regulation of their activities and inquiry processes, it is important to simultaneously provide structures that help students to coordinate their collaborative activities and guide them to reach a series of milestones rather than be left on their own. A special problem arising from our investigations is the challenge of coordinating (see Malone & Grawston, 2001) activities of students who may be distributed across time and space while engaging in using ITCOLE software. Traditionally, coordination has been achieved by keeping students under a teacher’s close supervision in face-to-face situations. New challenges, however, emerge in networked learning environments, in which students have to be able to themselves regulate their learning efforts. It appears that a great deal of coordination and structuring is needed in order to support adequate participation and to guide students to engage in in-depth inquiry. This coordination may partially be provided by the learning environment and partially by the learning community.

The required coordination may be created by designing a system (Coordination Tools) that help a teacher ands tutors, students and their teams set up main goals and sub-goals concerning their investigations. There should be a space for setting up a time table, milestones and shared goals of projects as a whole as well as corresponding aspects of a team’s or individual students’ inquiry. These Coordination Tools or functions may also involve means for individuals' and teams' self-assessment of the advancement in attaining the goals.

Designing Tools for Process Analysis

Various analyses carried out during the past years indicate that there is a need for sophisticated tools that allow tracking of students’ activities through their processes of participation in networked learning. Information of students' activities is very important for further development of the ITCOLE software because it help to model students' activity with the system and the extent to which students use various functionalities. This kind of tools would also provide a kind of sequential information of CSCL processes that is very difficult to obtain by other means.

Thus far, studies of CSCL activities have been carried out manually without sufficiently utilizing CSCL environment's log files or other information stored by the systems. There are, however, attempts going on for developing methods of process analysis as well as knowledge-building measures that rely on that sort of data. For instance, Knowledge Forum has a built in Analytic Tool Kit that provides researchers valuable information of the users' activities. It produces data that could be further processed by various statistical software packages. It is essential that these tools allow one to store all information produced in a project (including chat sessions and sessions with whiteboards) in a form that could be further analysed by systems for qualitative content analysis, such as Atlas.ti. This means that the data should be in text form and involve all computer entries organized either by time, author, topic, or some other indicator.

Providing Support for Community Building

A challenge of the ITCOLE project is to develop tools that help a partially or completely virtual community, or people working asynchronously, to manage their collaborative activities, build their community, and achieve mutual understanding. The software should support users in developing a sense of community and belonging even in cases when they are distributed across space and time. An essential aspect of building a community is to develop a sense of belonging, re-create one’s identity in relation to the virtual community, and build shared histories.

The process of community building may be facilitated through asynchronous and synchronous means. The former refers to various awareness tools and tools of social navigation that help the participants to be aware on-line of each other activities and participation as well as utilize knowledge and other things produced by their fellow students. It may also be possible to design virtual meeting places for members of a student team. It may be important that this kind of space is tailorable for the purposes of the project in question and to correspond the participants’ specific needs.

Awareness tools are kind of meta-tools that help people and their communities to manage, become conscious, and reflect on their collaborative activity. In many cases, these are concrete forms of representation that support communication and facilitate reflective interaction within a community (Jermann, Soller, & Muehlenbrock, 2001; Schlichter, Koch, & Chengmao, 1998; Munro, Höök, & Benyon, 1999; Häkkinen, Järvelä, & Dillenbourg, 2000). These tools are intended to help participants to be aware of each other's activities by mirroring their activities (i.e., presence of other participants with CSCL environment as well as intensity, quantity, quality and objects of participation). These may involve tools that provide online information of the development of participants social network (cognitive centrality, density of interaction, patterns of information flow and social support). It is important to model distributed processes of students, teachers, and their communities semantically by representing flows of their activities visually (e.g., histories of document versions, advancement of ideas or participation in key activities). These may also involve shared active representations and dynamic visualizations that allow the participants to interact through various modalities, such as visual or conceptual communication.

Pedagogically Meaningful Utilization of Virtual Realities

Productive knowledge sharing presupposes a high degree of trust and sense of belonging to a social community. It is essential to investigate how collaborative technologies help students and teachers who are distributed across space and may work in different locations, to build community and achieve mutual understanding. Toward this end, virtual reality environments may provide important resources.

Collaborative learning in network environments, and especially in virtual realities (Avatar worlds) appears to support participants’ social development because they are coached in collaborative problem solving and constructive interaction. It is important to use technology to support social development of the participants that are working together in a physical space, classroom. These environments allow the participants to explore their identities in relation to other members of the community and, thereby, develop a deeper sense of community. It might help them to break boundaries of their conventional role as teachers and students, and to change authority relations that determine interactions in conventional school situations. This may be conducted in a way that is in accordance with social values and norms of the community in question (Nardi & O'Day, 1998).

Although virtual worlds may provide a sense of place, possibilities to explore identity and engage in interaction, and be aware of fellow students' activities and thereby create a sense of community, it would be important to create practices that allow the virtual worlds to be used for supporting in-depth learning. While developing tools for synchronous communication, it is important to ensure that these tools do not only support social purposes, but have pedagogical relevance as well. How could the real world and virtual participation be combined in a way that supports learning? Could Avatars be ideas rather than people, as has been suggested by Carl Bereiter. Could participants of a learning community create key ideas or key problems that are represented within the virtual space and enriched with the users' own interpretations and explanations? Many core problems that students have to understand (e.g., evolution, Newtonian physics, human biology) are so complex that they offer an endless opportunity to achieve a deeper understanding. These ideas have not sufficiently been clarified in the ITCOLE process, and need to be addressed.

Content-specific Support for Learning and Knowledge Building

Even if it is justifiable to emphasize the significance of collaborative knowledge building that relies on shared problem solving, teachers has also to be able to make complex bodies of subject-matter knowledge available to students. Tools for mediating subject-matter knowledge to students may provide significant support for collaborative knowledge building if these tools are subsumed under an overall process of progressive inquiry and corresponding pedagogical practices. Progressive inquiry does not entail that there should not be deliberate and systematic teaching and studying of various domains of knowledge. It is essential, however, that direct instruction serves students' inquiry rather than replaces it or totally dominates it.

In order to facilitate advancement of students' conceptual understanding and to provide basis for their deepening inquiry, it may be important to incorporate to the ITCOLE environment tools (or use another program that provides corresponding tools in conjunction with it) that allow effective transmission of subject-matter knowledge relying, for instance, on the idea of educational object economy (see www.eoe.org). It might be useful to create documents based on XML technology that allow one to present subject-matter knowledge as dynamic cases or simulations that can be collaboratively commented, presented from different perspectives, and transferred from one environment to another. These types of documents allow one to present various kinds of contents in an effective way in different network environments. It may, however, be possible to use some other commercially available software to take care of this function.

8.2.3 The Importance of Integrating Technical and Pedagogical Development Work

ITCOLE proposal stated that the software is from the very beginning designed from a pedagogical perspective to support collaborative learning and knowledge building. This calls for a very close interaction between pedagogical and technical development of the system. A problem in creating design principles of CSCL is that implementation of these principles is dependent on available technical solutions. Even if we are able to generate a series of design principles, these principles rest on the air until they have been integrated with the specific technical solutions that are available for ITCOLE software and correspond accessible resources. Therefore, these guidelines are only half-baked until they have been discussed, negotiated, and further articulated between the designers and pedagogical experts.

The interdependency of technical and pedagogical development work appears to call for a closer integration between these two aspects of ITCOLE development. Although software and interface designing are strongly emphasized in the project proposal, these tasks cannot succeed without very close interaction with pedagogical aspect of the project. Therefore, an essential goal for the project is to build bridges between software or user-interface designers and pedagogical researchers.

A serious risk of the ITCOLE project is that both, software and user-interface designers, and pedagogical research community, form their own closed community that only asks formal input from each other, but there do not emerge actual mutual understanding or reciprocity. Because pedagogical principles are extremely complex and their application varies from one context to another, the only way of managing the problem is to create a unified community of both technical and pedagogical experts.

On the basis of these considerations, we would like to argue that the most important challenge of the ITCOLE project is to increase intensity of interaction between technical developers (programmers and user-interface designers) and pedagogical experts to ensure that the design solutions actually improve quality of learning.

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