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PREREQUISITES FOR CSCL: RESEARCH APPROACHES, METHODOLOGICAL CHALLENGES AND PEDAGOGICAL DEVELOPMENT

Päivi Häkkinen[1]

University of Jyväskylä, Institute for Educational Research, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland, Tel: 358-14-2603231, Fax: 358-14-2603201, Email: paivi.hakkinen@ktl.jyu.fi

Maarit Arvaja

University of Jyväskylä, Institute for Educational Research, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland, Tel: 358-14-2603253, Fax: 358-14-2603201, Email: marvaja@cc.jyu.fi

Kati Mäkitalo

University of Jyväskylä, Institute for Educational Research, P.O. Box 35, FIN-40014 University of Jyväskylä, Finland, Tel: 358-14-2603308, Fax: 358-14-2603201, Email: kati.makitalo@ktl.jyu.fi

Abstract

The ideas presented in this article are especially challenged by critical questions raised by the recent research approaches to collaborative learning in computer-supported settings. The question arises whether participants in computer-supported collaboration are able to successfully work on a common task and achieve a type of interaction that leads them to educationally relevant higher-level discussion and learning. This article will first discuss the central concepts and recent research trends in the area of collaborative learning. Further, the sometimes contradictory findings of research on Computer-Supported Collaborative Learning (CSCL) are presented. The aim of CSCL is to integrate research on collaborative learning with the use of Information and Communication Technologies (ICT). In the context of research on CSCL, it is also essential to consider the recent methodological challenges this work poses for studying collaborative learning in computer-supported settings. Finally, the pedagogical and contextual prerequisites and constraints for the formation of collaborative groups around mutual interests, skills and needs are described and suggestions are made on the basis of the recent research.

Keywords: collaborative learning, Computer-Supported Collaborative Learning (CSCL), methodological aspects, pedagogical implications.

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[1] Correspondence concerning this manuscript should be addressed to the first author.

Introduction

One of the essential requirements in the rapidly changing society is to prepare learners for participation in socially organized activities and in building socially shared expertise. A focus on purely individual cognition has set a stage to social construction of knowledge (Greeno, 1998), and new learning environments are often based on collaborating and sharing expertise (Dillenbourg, 1999). Collaborative learning is nowadays a fashionable phenomenon, but collaboration among students in various learning settings (e.g. in classrooms) is a much more complex phenomenon than has often been thought. Let's just think about the following typical cases of collaborative learning in small-group working described by Salomon (1992):

- "Free-rider effect": one team member just leaves it to the others to complete the task.
- "Sucker effect": a more active or capable member of a team discovers that (s)he is taken for a free ride by other team members.
- "Status sensitivity": active or capable members take charge and have an increasing impact on the team's activity and products.
- "Ganging up on the task": team members collaborate with each other to get the whole task over with as easily and as quickly as possible.

This makes one ask why true collaboration does not happen more often? What makes it so difficult? And yet why is it, on the other hand, so tempting as a spontaneous phenomenon among small children? This article will first discuss the central concepts and recent research trends in the area of collaborative learning. Further, the sometimes contradictory findings of research on Computer-Supported Collaborative Learning (CSCL) are presented. And finally, methodological, as well as pedagogical and contextual prerequisites and constraints are considered.

From individual minds to collaborative knowledge construction and sociocultural approaches

In the history of research on collaborative learning, several researchers have anchored their research on two main traditions: namely Vygotsky's (1978) sociocultural approach and neo-Piagetian ideas of socio-cognitive conflict (e.g., Doise 1985). Later notions of social aspects of learning vary from perspectives focusing on individuals that participate in group activities (Anderson, Reder & Simon, 1997) to perspectives focusing on groups that are made up of individuals (Greeno, 1998). In addition to individual, cognitive perspective to learning and expertise (Anderson et al., 1997), the focus of recent learning research has moved more to examining how experts typically function in social contexts such as in teams and communities of practice. Theories referred to as situated cognition describe training as the process of entering a community of practice through peripheral legitimate participation (Lave & Wenger, 1991). It is assumed that learning becomes more effective when individual's participation into a community of practice is more central. In other words, learning is not viewed as the mere acquisition of concepts or skills but as the appropriation of the culture specific to the target community.

Anderson, Reder and Simon (1997) and Greeno (1998) have framed conflicts between cognitive and situated learning theories. The main difference between cognitive and situated perspectives can be seen in their interpretations of social processes. Lave and Wenger (1991) have criticized that participation in social practices does not only influence otherwise autonomous psychological processes, but learning is synonymous with changes in the ways that an individual participates in social practices. In the situated approach, participation into social practice or context is not restricted to face-to-face interaction with others. Instead, all individual actions are viewed as elements of broader system of social practices. Therefore,

individuals can be seen as participating in social practices even when they act in physical isolation from others (Cobb & Bowers, 1999; Forman, 1996). Furthermore, theories of distributed cognition emphasize a process in which cognitive resources are socially shared in order to extend individual cognitive resources or to accomplish something more than what individuals could achieve alone. In this approach, cognitive processes can be distributed, not only between social actors, but also between social actors and physical artefacts of learning environment (Hutchins, 1995; Salomon, 1993). However, while emphasizing knowledge as an aspect of practice, discourse and activity, what often stays without much attention is the question of how much or how well organized knowledge individual students acquire. Besides the description of activities and discourse processes, we should also consider the knowledge acquisition of individual students in collaborative learning environments (Lehtinen, Hakkarainen, Lipponen, Rahikainen & Muukkonen, 1999).

While emphasizing the meaning of social context in learning, researchers also often struggle with the issues related to the unit of analysis. Cobb and Yackel (1996) have claimed that the choice in any particular case is pragmatic and depends on the purpose at hand. In socio-cultural theories, the unit of analysis is groups of individuals participating in broad systems of practices (Lave & Wenger, 1991). Socio-constructivist theories, on the other hand, focus on individual students' seek after meaning and understanding while simultaneously viewing reasoning as an act of participation in evolving communal practices (Palincsar, 1998).

While some studies concentrate on understanding how individuals become members in a large community as they do in apprenticeship studies (Rogoff, 1990), other studies focus more on how members of cognitive community can construct shared understanding in the first place (Roschelle & Teasley, 1995). For instructional design of powerful learning environments, it is also important to recognize the qualitatively distinct ways in which

individual students participate in particular practices (Cobb & Bowers, 1999). In addition, in ethical sense students must have a way to participate in the practices of the classroom community. If they cannot participate, they are not members of the community any more. Therefore, what is needed now is to better understand how individuals' mental and developmental processes relate to social and situational factors that influence collaborative learning and performance.

It has become clear that the line between individual and social processes of learning is blurring, and the main message of many researchers is that we should see individual minds in interaction with group understandings (Stahl, 2002). In research on collaborative learning, we should also call for approaches that converge different streams of research. One example of such convergence is presented by Baker, Hansen, Joiner and Traum (1999). In order to understand the role of grounding in collaborative learning tasks, they combined socio-cultural approach and the cultural-historical activity theory (Cole & Engeström, 1993) to the cognitive studies of collaborative problem solving which focus on the mechanisms by which partners maintain a shared and mutual understanding of the task at hand (Roschelle & Teasley, 1995; Schwartz, 1995). Further one, to understand how two partners maintain some mutual understanding (grounding process), they referred to the linguistic studies (mainly in pragmatics). According to their perspective, culture is the language that subjects have to develop to interact efficiently about the task at hand. Furthermore, conversational and other interactional conventions of communities are well-coordinated patterns of participating in social practices. It can also be hypothesized that systematic development in the ability to participate into practice (e.g. turn-taking and other means of using language) occurs over long-term period of time.

Defining the concept of collaborative learning

There is a consensus among researchers, that collaboration involves the construction of meaning through interaction with others and can be characterised by a joint commitment to a shared goal (Littleton & Häkkinen, 1999). Furthermore, collaborative learning is often defined in a way that necessitates participants to be engaged in a co-ordinated effort to solve a problem or perform a task together. This coordinated, synchronous activity is the result of a continued attempt to construct and maintain a shared conception of a problem (Roschelle & Teasley, 1995).

One of the emerging themes in research that is focusing on collaboration as a co-ordinated activity is research on grounding processes and social negotiations. In the grounding phase of co-ordinated problem solving, the participators negotiate common goals, which means that they do not only develop shared goals but they also become mutually aware of their shared goals. Common goals form the basis for joint work, and negotiation of common goals is part of the interactive process of grounding. The grounding process has been described in the settings that consider communication as a form of collaborative action (Brennan, 1998; Clark & Brennan, 1991; Clark & Schaefer, 1989). During the grounding process, individuals build and maintain common ground by sharing mutual understanding, knowledge, beliefs, assumptions and pre-suppositions (Brennan, 1998; Clark & Schaefer, 1989). Participants exchange evidence of their understanding and of the fact that they are talking about the same thing until they have reach the common ground (Clark & Schaefer, 1989). If shared understanding is incomplete, the continued interaction might be threatened, because too much effort and time are needed for re-construction of shared understanding.

There is empirical evidence demonstrating the positive effects of social interaction for individual learning in organized problem solving settings (Light, Littleton, Messer & Joiner,

1994; Roschelle & Teasley, 1995). Collaborative learning situations seem to provide a natural setting for self-explanation and explaining to others as well as other forms of knowledge articulation, which have been shown to demonstrate positive effects for learning (Ploetzner, Dillenbourg, Preier & Traum, 1999). Collaborative cognitions can also promote the use of abstract representations among collaborators more efficiently than individuals working alone on the same problem (Schwartz, 1995). An explanation for this is that the collaborative task places demands on partners to create a common representation that bridges the multiple perspectives they hold individually on the problem structure and situation. This representation tends to be at a more abstract level than the representations formed from any single viewpoint.

Focus on process and context of collaboration

Recent research interests have shifted away from analysing the outcomes and products of collaborative work or from establishing whether collaborative learning is more effective than individual learning. Instead of treating collaborative learning as a single learning mechanism, the focus has been directed more towards analysing interactions as a means of gaining insight into the processes of collaborative learning. The aim of such analyses is to identify what constitutes productive collaborative activity (Littleton & Häkkinen, 1999). Recent research on collaborative learning has also called for more exact use of terminology related to the specific forms of collaboration (Dillenbourg, 1999). Collaborating participants learn if they generate certain collaborative activities (argumentation, explanation, mutual regulation etc.), which trigger learning mechanisms such as knowledge elicitation and reduced cognitive load. Baker (2002) has suggested that there is a need to move beyond simple demonstrations of the advantage of group conditions and focus on studies that seek to understand the processes of collaborative interaction itself and its contribution to learning.

In addition to the cognitive variables, recent research trends have also emphasized the importance of affective and motivational variables of collaborative learning (Crook, 2000; Joiner, Littleton, Faulkner & Miell, 2000; Stahl, 2003). For example Crook (2000) has pointed out that current conceptions of collaboration focusing on cognitive skills do not pay attention to collaboration as something that is motivated. It is relevant, for example, to ask what then makes students engage in collaborative activities and how the circumstances for potential collaborations are enhanced. Furthermore, does seeking after shared meaning require intentional activity or does it happen spontaneously? What makes playful and informal collaborations so appealing? Examining these kinds of questions presupposes a strong emphasis on situated and sociocultural theories of learning.

Crook (2000) has introduced the idea of ecology of collaboration, which refers to certain forms of productive joint engagement in learning. By this he wants to focus on the settings in which collaborations are organized, in other words actual spaces within which collaborations are either constrained or resourced. This kind of ecological perspective helps us to understand which circumstances will lead people to work together well and which circumstances will lead them to prefer to work alone. He argues that the ecology is about the immediate environments within which collaborative learning is supported – the artefacts, the technologies, and the spaces for acting. Also Stahl (2003) has emphasized contextual features of collaborative learning by suggesting that situation reflects previous social activities, and is transformed by current interactions and projections of the future. To sum up, while aiming to understand the diverse viewpoints to collaborative learning, we have to consider an extremely complex set of variables: cognitive, social, emotional, motivational and contextual variables interacting with each other in a systemic and dynamic manner.

Computer-Supported Collaborative Learning (CSCL) and Computer-Supported Co-operative Work (CSCW)

Research on collaborative learning and the use of Information and Communication Technologies (ICT) has been integrated in the emerging research area called Computer-Supported Collaborative Learning (CSCL), which aims to create powerful learning environments with the aid of groupware and communication technologies (Koschmann, 1996). Two traditions that have strongly contributed to the development of CSCL tradition are research on co-operative (e.g. Forman & Cazden, 1985) and collaborative (e.g. Dillenbourg, 1999) learning as well as research on Computer-Supported Cooperative Work (CSCW) (Dourish, 1998). Although there is no unified theory of CSCL, the common feature of the diverse standpoints is to focus 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. CSCW, on the other hand focuses on the collaborative nature of work supported by groupware. The latter tradition has excluded the issues of learning, but has provided basis for developing groupware tools for learning purposes.

Guribye, Andressen and Wasson (2003) have outlined the organisation of interaction in distributed collaborative learning. They have particularly contrasted the field of CSCL to the field of CSCW. In Computer-Supported Co-operative Work, the focus of attention is put on cooperative practices, and cooperative work is mainly seen as an activity in which workers are interdependent of each other (Schmidt & Bannon, 1992). Schmidt (2001) has also claimed that compared to Computer-Supported Collaborative Learning, discordant interests and motives among workers are often relegated to the background. Furthermore, in a typical

cooperative work setting, the workers perform the same tasks everyday and work is a routine activity exploiting domain-specific skills. In contrast to learning situations, making sense is also viewed as effortless, and outcomes and actions of others are seen as predictable (e.g. Heath & Luff, 1996). CSCW systems support sharing and archiving of knowledge that is an aggregate of the contributions of cooperative individuals (Guribye et al., 2003).

The field of CSCL, on the other hand, focuses on functioning of collaborative groups when they are building knowledge that is the shared creation and property of the group (Stahl, 2002). Compared to workers, students form a more diverse population with unstable membership and no shared objective. In CSCL communities, the process of collaboratively constructing the shared knowledge and arriving at instructions of what actions to perform is important (Stahl, 2002). It is also worth noticing that making sense of each others actions is a constant struggle, and important properties are also the issues of interests and motives (Guribye et al., 2003).

CSCL tools usually offer a fairly open collaboration space where learners are in the centre of the communication process (Bourguin & Derycke, 2001). Important feature in open spaces for collaboration is the need to negotiate the flow of actions to do, which emphasizes the coordination and awareness support in distributed collaborative learning more than in distributed collaborative working. When participants negotiate a shared objective and horizon, they need to understand the conditions for collaboration and rules for coordinating the collaborative effort at the same time when solving the learning tasks (Guribye et al., 2003). The situation becomes even more complex when previously unknown people meet in distributed learning groups. It is hard to reproduce creation of mutual understanding or shared values and goals in a distributed learning environment because of the absence of visual information and non-verbal cues (Järvelä & Häkkinen, 2002). At the beginning of any interaction there will be some degree of common ground between individuals who share the

same cultural background, but also participants with a shared culture need to build and maintain common ground during the interaction itself in order to explore new aspects of their mutual knowledge (Baker et al., 1999).

Benefits and constraints of CSCL

Positive results have been received in CSCL experiments, and many advanced technical infrastructures (such as CSILE and Knowledge Forum, created by Scardamalia & Bereiter, 1994) for fostering higher-level processes of inquiry-based interaction have been developed (e.g. Scardamalia & Bereiter, 1994). For example, shared workspaces and communication tools can provide a natural setting for explanation, knowledge articulation, argumentation and other demanding cognitive activities (Häkkinen, 2001; 2002). They can also enable sharing and distributing of cognitive load and bring thinking out into open (Miyake, 1986). In other words they can function as a collective memory for a learning community helping the storage of the history of knowledge construction process for revisions and future use. Recent studies have revealed that in connection with corresponding pedagogical practices, CSCL environments can facilitate higher-level cognitive achievements such as critical reasoning, explaining, generating own research questions, setting up and improving one's own intuitive theories, and searching for scientific information (Scardamalia & Bereiter, 1994; Hakkarainen, Lipponen & Järvelä, 2002).

There is also research demonstrating the possibilities that technology can provide to support, structure and re-organize shared problem solving in small groups around the same computers. Many researchers have argued that this way computer can offer a mediating artefact that fosters optimal conditions for reciprocal interaction (Järvelä, Bonk, Lehtinen & Lehti, 1999).

Research results of computer support for collaborative learning have, however, been contradictory, and several studies have indicated collaborative learning to be a complex phenomenon and difficult to realize in our institutionalized schooling (Baker, 2002; Häkkinen, 2001). Collaborative processes are often over-generalized and simplified by treating collaborative learning either as a single psychological process or a pedagogical method. It is worth remembering that interacting in small groups around computers in face-to-face situations for one or two hours differs in many respects from the situation where hundreds of people participate in distributed on-line course during one year. Furthermore, any tools for communication and correspondence are called 'collaboration tools' (Roschelle & Pea, 1999). The problem is that if almost any interaction situation is called collaborative, it is difficult to judge whether and when people learn from collaborative situations (Dillenbourg, 1999; Littleton & Häkkinen, 1999).

According to Kreijns, Kirschner and Jochems (2001), social interaction is taken for granted in CSCL environments. There is the assumption that interaction will automatically happen in the CSCL environments nevertheless many studies report that discussion threads are short and participation rates are low. Furthermore, it is typical for collaborative interaction in CSCL environments that it deals with descriptive and surface-level knowledge instead of finding deeper explanations for the phenomena under study (Järvelä & Häkkinen, 2002; Arvaja, Rasku-Puttonen, Häkkinen & Eteläpelto, 2003). One of the problems seems to be in participants' engagement to the web-based work (Oliver & Shaw, 2003). A crucial problem is also related to the process of collaboration is the difficulty in making inquiry questions that would evoke elaborated explanations. Further on, particular challenges are related to reaching of reciprocal understanding, shared values and goals in networked environments (Järvelä & Häkkinen, 2002).

To reach and maintain an adequate level of common ground, which is essential in collaborative activities (Dillenbourg, 1999), the participants need to be aware of 1) the presence of others, 2) the process of diagnosis; participants have to think what they are saying but also how they are saying it, and 3) feedback; participants need to show their understanding in some form of feedback (Baker et al., 1999; Brennan, 1998). Participants also have to maintain common ground during the interactive processes to be able to deal with emerging new aspects of the common situation or task (Baker et al., 1999). For maintaining common ground individuals need to be willing and able to continue the interaction, observe a message in the web-based environment, understand the message and react and respond to the message. All these elements – contact, perception, understanding and attitudinal reaction – are linked together; an attitudinal reaction between persons cannot take place unless the message is first understood (or at least interpreted), which requires perception and contact (Baker et al., 1999; Clark & Schaefer, 1989).

According to Brennan (1998), even if the feedback consists of a simple acknowledgement that the message has been noticed and read, it is necessary for avoiding undue doubts of some participants that others are not reading the messages they post, and also for reaching mutual understanding. In the study of Mäkitalo, Häkkinen, Järvelä & Leinonen (2002), the results reveal that in deeper level discussions, supporting feedback was more frequent. The results suggest that positive feedback encourages people to participate in discussion and thereby engage in the group actively contributing to the web-based learning environment (see Hara, Bonk & Angeli, 2000). Furthermore, McMillan (1996) proposes, that the members of the community need support and to be able to offer support in times of need. According to Wegerif (1998), creating a sympathetic sense of community is a necessary first step for collaborative learning.

Also Kreijns, Kirschner and Jochems (2002) mention that the social dimension of social interaction is not considered enough at the cost of cognitive dimension. For example Wegerif (1998) noted that for collaborative learning it is necessary that people feel that they can reveal their own feelings, assumptions and knowledge without treating badly by their fellow participants in a web-based environment. Also Oliver and Shaw (2003) suggest that the essential role on the personal, affective element of the students' context plays the enthusiasm and expertise of the tutor which might foster engagement even more than e-moderating skill in the web-based conferences. It seems that also the enthusiasm of the fellow students might foster engagement especially in small group context, which is important aspect of interaction to continue successfully (Mäkitalo, Pöysä & Häkkinen, 2003). Altogether it can be concluded that at best, CSCL environments can support cognitive, social, motivational and affective processes of learning, but also the constraints can be related to any of these viewpoints.

Methodological challenges for studying CSCL

In research of computer supported collaborative learning typical research methods have been content analysis of networked discussions, different types of discourse analysis or quantitative summaries of computer-generated databases. Some researchers have also used social network analysis methods to visualize students' participation and roles in computer-supported collaborative learning. They report that a social network analysis is an appropriate method for studying structures of interaction and relationships in a technology based learning environment (Nurmela, Palonen, Lehtinen & Hakkarainen, 1999). These methods offer insight into the content and quantity of students' networked discussions as well as interaction structures in a general level. However, these methods are not capable of revealing the quality of collaborative processes of the network and the ways in which collaborators shape each

other's reasoning processes, neither do they reveal individuals' personal experiences or interpretations.

There is growing evidence that learning in collaborative learning environments cannot explained as only the result of specific abilities but appears as the product of complex and dynamic interactions between cognitive, social, affective and motivational variables (Pintrich, Marx & Boyle, 1993). What is needed now is to better understand how individuals' mental processes relate to social and situational factors that influence cognitive performance and learning. Consequently, new methods are needed to capture the process of collaborative interaction and its contribution to learning. Furthermore, these methods should be able to understand the process of computer-supported collaboration as part of the wider social context of the participants.

While seeking methodological accounts for capturing e.g. the processes of collaborative learning or community-building, we should bear in mind that the analysis of collaborative interaction cannot be isolated from the context in which it is embedded (Crook, 1999). To find out more about the nature of collaborative learning processes and what promotes collaborative knowledge building, different features affecting learning must be studied in the context of the joint activity, i.e. with relation to and in the form they occur in different learning environments. Also Salomon (1997) has stated that it is the whole culture of learning environment with several intertwined variables that influence learning in a fundamental way. Thus, the analysis of CSCL settings should go beyond networked interaction by including the activities in face-to-face settings as well as taking account the previous history of the students participating in the learning activity (Crook, 2000). The unit of analysis should be the whole activity system of tasks, artefacts, interactions, symbols, social practices, roles and community of practice, which absorbs the shared knowledge of the group (Stahl, 2003).

Pedagogical and contextual prerequisites for CSCL

The most optimistic views suggest that global networks and the use of computers for intellectual communication will further enhance and expand the ways in which humans connect, communicate, and create a sense of community. However, more critical questions about the possibilities and quality of virtual learning environments have been presented as presented earlier in this chapter. The biggest challenge of researchers and practitioners it to develop innovative, many-sided pedagogical practices and models, utilizing ICT that can support students in their efforts for deeper-level learning and interaction.

However, on the basis of the research on collaborative learning and CSCL, several lessons can be learned concerning the pedagogical and contextual prerequisites for successful collaborative learning situations. Some of the most important processes in human communication, like the creation of mutual understanding, shared values and goals, are hard to reproduce in a Web-based environment (Järvelä & Häkkinen, 2002). The absence of visual information (e.g. missing facial expressions and non-verbal cues) increases the social distance between the participants (Järvelä & Häkkinen, 2002; Rovai, 2000). Therefore, it is important to consider how common ground could be created and maintained in virtual environments (Mäkitalo, Häkkinen, Järvelä & Leinonen, 2002). According to Dillenbourg and Traum (1999), grounding can occur at the linguistic level as well as at the cognitive level. Furthermore, Veerman (2000) proposes that grounding can take place also at the level of understanding thematic information in relation to certain task and learning goals. The recent research suggests that it is essential to consider also the role of socio-emotional level of grounding in future collaboration situations (Mäkitalo, Pöysä & Häkkinen, 2003).

One crucial determinant of successful collaboration is related to the nature of learning task (Arvaja, Häkkinen, Rasku-Puttonen, Eteläpelto, 2000). Unlike fact-seeking questions and unambiguous tasks, open-ended and discovery tasks (Cohen, 1994) have been seen to promote joint problem solving and reasoning. Too obvious, or unambiguous tasks do not leave space for disagreements, misunderstandings, questions, negotiations, explanations and arguments. Therefore, one of the biggest challenges in instructional design and support of CSCL is to provide real group tasks and contexts that enhance questioning, explaining and other forms of knowledge articulation. Also when considering the role of cognitive conflict in learning, it is important to bear in mind that it is not the conflict itself that is crucial and beneficial in terms of learning, but it is the process of solving the conflict. Further, conflicting situations might sometimes also turn out for social conflicts, which could cause these time-outs that are needed for solving the cognitive conflict (Dillenbourg, 1999; Littleton & Häkkinen, 1999).

It has also been suggested that in instructional design of collaborative learning tasks and scenarios, the possibilities of cognitive diversity and participants' positive interdependency of each other should be taken into account. By utilizing cognitive diversity, the kinds of learning environments can be designed where participants have different perspectives and overlapping areas of expertise, but they also share expertise from different areas (Brown & Campione, 1994).

Dillenbourg (2002) has recently called for approaches that help us to structure collaborative learning situations due to the fact that free collaboration does not systematically produce learning. Collaboration can be promoted by structuring the collaborative process beforehand in order to favour the emergence of productive interactions. One way to structure interactions is to design predefined collaboration scripts into CSCL environments. These scripts are sets of instructions prescribing how students should form groups, how they should

interact and collaborate and how they should solve the problem (Dillenbourg, 2002; Hoppe & Ploetzner, 1999). Scripts can be seen as a way to influence collaboration that is complementary with tutors or mentors attempt to regulate interactions afterwards.

According to Dillenbourg (2002), the effectiveness of scripts is based on the idea of integrating usually separate activities: individual, cooperative, collaborative and collective activities. Furthermore, scripts enable to integrate co-present activities and computer-mediated activities. They also introduce a time frame in distance education where students often lack landmarks for their time management. The other side of the coin in designing well-defined scripts is the risk of over-scripting collaboration. Predefined scripts can disturb the richness of natural interaction and problem solving processes. Furthermore, this kind of 'educational engineering' approach can lead to reaching for effectiveness at the cost of the genuine notion of collaborative learning (Dillenbourg, 2002). The balance between the benefits and risks of structuring collaboration depends on the core mechanism that the script is based on, in other words how designer aims to foster productive interactions and learning. For example, leaning on participants' cognitive diversity and knowledge interdependency fosters different mechanisms than the purely vertical task division in collaborative groups.

Conclusions

In this chapter, we first took a look at the recent research on collaborative learning and Computer-Supported Collaborative Learning (CSCL). On the basis of this, several methodological and pedagogical challenges were raised. In addition to the need for pedagogical and contextual models, also the collaborative tools themselves should be designed to better take into account the challenges of human communication and learning in networked environments. From the viewpoint of technology, networked environments used in

different learning environments just need to provide a learner with a relevant platform for communicating and sharing knowledge. Instead, more advanced technological solutions to support many problematic issues in virtual interaction, such as difficulties in reaching shared understanding, in co-ordinating different perspectives or in establishing the sense of co-presence especially in distributed teams are still missing (Gutwin & Greenberg, 1999; Häkkinen, Järvelä & Dillenbourg, 2000; Munro, Höök & Benyon, 1999).

It can also be assumed that collaborative learning sets new demands on students and teachers by challenging the traditional practices and support structures of educational settings. For example, learning from doing complex, challenging and authentic projects collaboratively requires resourcefulness and planning by the student, new forms of knowledge representation in school, expanded mechanisms for collaboration and communication, and support for reflection and authentic assessment (Häkkinen, 1999). Computers can be seen as essential elements in re-structuring social interaction and knowledge building, and social construction of knowledge is also strongly associated with creation of new kind of learning culture (Hakkarainen et al., 2002; Scardamalia & Bereiter, 1994). Although this culture has real opportunities from the point of view of learning, it is not realized in a moment and without problems. It can be hypothesized that the traditions, structures and processes of institutionalised schooling do not support collaborative forms of learning. However, learning environments that are seen beneficial from the viewpoint of learning require reasoning, evaluating, critical discussion and making learning processes transparent. If CSCL environments inspire these activities, they can have a crucial importance for innovating new instructional practices that lean on more open sharing of ideas.

Although the scientific community has regarded the principles of CSCL as highly promising, they are extremely difficult to be implemented among teachers and other practitioners. In addition, one of the critical points in CSCL research is the scaling up of the

models of intensive pilot experiments – it has proved to be extremely difficult to implement schemes more broadly (Sinko & Lehtinen, 1998). Although teachers and students have access to computers, technology is not intensively used, at least not in pedagogically advanced ways. Good practices usually emerge in pilot projects supported by researchers rather than modifying and revising these practices to be part of a new culture of schooling (Hakkarainen et al., 2002; Lipponen, 2001). New sustainable pedagogical practices require long-term commitment to develop them in close collaboration between researchers and practitioners, and gradually they can trigger changes in the learning culture.

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