Exploring Foundations for Computer-Supported Collaborative Learning

Lasse Lipponen

Department of Psychology, University of Helsinki
P.O. Box 1300014 University of Helsinki, Finland
Lasse.Lipponen@Helsinki.Fi
Tel. +358-9-19123772 fax: +358-9-19123443

ABSTRACT

In 1996 Koschmann (1996) suggested computer-supported collaborative learning (CSCL) as an emerging paradigm of educational technology. After six years, how has the field developed? What does research say about CSCL to date? What is the state of the art? The aim of the present paper is to explore the foundations for CSCL, and in doing so, to contribute to the theoretical as well as empirical understanding and development of CSCL research.

Keywords:

Collaboration, collaborative technology, learning theories

INTRODUCTION: WHAT IS COMPUTER-SUPPORTED COLLABORATIVE LEARNING (CSCL)?

In 1996 Koschmann (1996) recognized computer-supported collaborative learning (CSCL) as an emerging paradigm of educational 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, CAI (Computer Assisted Instruction), ITS (Intelligent Tutoring Systems), and, Logo-as-Latin did. But now after six years, how has the field developed? What does research say about CSCL to date? What is the state of the art?

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, 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.

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 1990 (Koschmann, 1994), and the first international CSCL conference was held 1995 in Bloomington, Indiana. However, O'Malley and Scanlon already used the term computer-supported collaborative learning in 1989 (O'Malley & Scanlon, 1989). 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, & Egido, 1990; Greenberg, 1991) Thus, in a sense, CSCL is the younger sibling of CSCW.

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. 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, cooperative 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).

At first glance, the speculation about the meaning of the "C" word and the acronym might look somewhat meaningless. This conversation is, however, related to the central questions concerning CSCL such as, What is collaboration, What are we studying when we are studying collaboration supported by technology, and, What should we be studying?

Concepts and Theories underlying CSCL research

Concepts of collaboration

When referring to collaboration, about what is one actually speaking? To put it simply, in the public conversation the term 'collaboration' appears to refer to any activities that a pair of individuals, or a group of people perform together. Among researchers, however, including those in academic fields, the term 'collaboration' is understood rather differently. Within learning sciences, common to the different definitions of collaboration is that they stress the idea of co construction of knowledge and mutual engagement of participants. In this sense, collaboration can be considered as a *special form of interaction*. Rochelle and Teasley (1995) for instance, stressed the role of shared understanding, and wrote that collaboration is "a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (p. 70). Or consider Crook (1994) who offers an intriguing perspective on collaboration. He holds that there is a developmental line from children's secondary intersubjectivity and symbolic play to sophisticated reciprocal understanding and shared knowledge. In children's symbolic play, the material world plays a crucial role in coordination of play activities and in creating a shared framework for collaboration. Most theories or approaches to collaboration neglect the impact and possibilities of the material world for facilitating mutual understanding and shared goals. However, the management of the material world offers rich referential anchors for monitoring grounding and mutual understanding. Computers, especially, can offer a rich repertoire of referential anchors, and points of shared reference (e.g. simulation on a screen). According to Crook (1998), there are three features of interaction that are central to successful collaboration: intimacy among participants, rich supply of external resources, such as computers, and histories of joint activity of those interacting. Further, Engeström (1992) has elaborated a three-level notion of developmental forms of interaction; coordination, cooperation, and reflective communication. On the level of coordination each actor concentrates and performs his or her own role and actions, which are scripted or predetermined. In 'cooperative' interactions, says Engeström, actors focus on a shared problem, trying to find mutually acceptable ways to conceptualize it. This level corresponds to the definition of collaboration (although Engeström uses the concept, 'cooperation'), just given, above, from Roschelle and Teasley (1995). The third form of interaction elaborated by Engeström is reflective communication, in which the actors focus on reconceptualizing their own interaction system in relation to their shared objects of activity; both, the objects and the scripts are reconceptualized. Only through this expansive cycle, is the interaction system transformed, and new motives and objects for collaborative activity created. The advance of this model is that it tries to explain how new forms of collaborative activities are created. According to Engeström (1992), these three phases are a natural cycle of any genuine learning activity.

There exist also broader definitions of collaboration than those referring to a special type of interaction, such as stressing the mutual engagement of the parties (in fact, Engeström's third definition, reflective communication, could also be considered as "participating in activity system", and thus, representing broader definition of collaboration than just stressing the mutual engagement). Collaboration can be defined as a *process of participating in knowledge communities*. As pointed out by Brufee (1993, p.3) collaboration is "a reculturative process that helps students become members of knowledge communities whose common property is different from the common property of the knowledge communities they already belong to". Scardamalia and Bereiter (1994) speak about knowledge-building communities. Knowledge building is a special form of collaborative activity oriented towards the development of conceptual artifacts, and towards the development of collective understanding. In a community of learners, as proposed by Brown and Campione (1994), the core activity is participation in collaborative process of sharing and distributing expertise. As stated by Brown (1994, p. 10), "Learning and teaching depend on creating, sustaining, and expanding a community of research practice. Members of the community are critically dependent on each other. No one is an island; no one knows it all; collaborative learning is not just nice, it is necessary for survival". The idea that collaboration is a basic form of human activity, essential for cultural development, is stressed intensively by many writers throughout the history of psychology (Bruner; 1996; Engeström, 1987; Hutchins, 1995; Mead, 1934; Tomasello, 1999; Vygotsky, 1962; 1978; Wundt, 1921).

In sum, even this very short look to the definitions of collaboration has shown how difficult it is to find a total consensus in this issue, although both approaches, collaboration as a special form of interaction, and collaboration as a process of participation in collective activities ("working together"), include the idea of achieving shared goals. One may ask whether we even need an agreed interpretation of collaboration, or should we just accept the diversity, and let the future determine which definitions will survive. It appears that we can--that perhaps we must--analyze collaborative activities on both micro and macro levels, and, as proposed by Dillenbourg (1999), concern ourselves with aspects such as situation, interactions, processes, and effects.

Theories of collaboration

Whether one considers collaboration as a special form of interaction or as a process of participation, traces back to the conversation of two metaphors of learning, acquisition and participation, or on the debate between the cognitive perspective and the situative perspective of learning (Anderson, Greeno, Reder, & Simon, 2000; Sfard, 1998).Within

acquisition metaphor learning is a matter of construction, acquisition, and outcomes, which are realized in the process of transfer. Within the participation metaphor cognition and knowledge are distributed over both individuals and their environments, and learning is "located" in these relations and networks of distributed activities of participation. Learning and collaboration are not only a matter of epistemology but also a matter of ontology. Knowledge is not all that is constructed but also humans and their identities are constructions; learning is also a matter of personal and social transformation (Packer & Goicoechea, 2000). This ontological line of research should be considered also more in the CSCL research .

Whether relying on the acquisition or participation metaphor of learning, there exist two main theoretical perspectives for a mechanism promoting learning in a CSCL setting. These perspectives, which seem to be agreed among researchers, trace back to the thinking of Piaget and Vygotsky. 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 more the idea of co-construction of knowledge and mutual understanding. 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; Järvelä & Häkkinen, in press).

The second well-known mechanism for promoting learning in context of social interaction is formulated on the basis of 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 internalization in collaborative learning. In other words, collaboration is interpreted as a facilitator of individual cognitive development. The other interpretation of Vygotsky's ideas emphasizes the role of mutual engagement and co-construction of knowledge. According to this perspective, learning is more as a matter of participation in a social process of knowledge construction than an individual endeavor. 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. In many cases the theories of Piaget and Vygotsky are seen to represent opposite explanations of human development and learning. In the future, a fruitful approach might be to attempt to reconcile these two perspectives (Hickey & McCaslin, in press; Packer & Goicoechea, 2000).

Empirical research on CSCL

Whilst the antecedents educational technology paradigms 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. Typical methods for analysis are ethnographical methods and discourse analysis with descriptive, observational, and non-experimental data. Stress is put on the ecological validity of the research. In contrast to its predecessors that studied human cognition with experimental design and in laboratories, CSCL research is conducted also in "real world contexts", for instance, at schools.

What then should researchers study in the context of CSCL? 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, analyze a posteriori 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 in collaborative interactions zoom in more intensively on the micro level.

If one studies only interactions of mutual engagement one can then ask, what is the relevance of CSCL research at schools, or in workplaces in general. The dilemma is this: if collaboration is understood as "a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (Roschelle & Teasley, 1995, p. 70), it refers to a form of interaction that can be, strictly speaking, maintained only among a small number of people, and perhaps, only in face-to-face situations. An approach to collaboration solely in terms of face to face encounters among small groups appears, however, to be very limited approach to CSCL, for it is very common to speak

about collaboration and learning communities in the same context, and related to networked learning environments. As pointed out earlier, collaboration can also considered as a process of participating in practices of a community.

How then, should one speak about and analyze collaboration at the collective (macro) level? One idea would be to think about communities as interaction networks, and interactions representing strong and weak links among participants. Links among community members that frequently meet each other are usually strong, and conversely (see Granovetter, 1973). We may assume that strong links and intensive interaction among community members also represent intensive and productive collaboration. Thus, as pointed out by Wellman and others (Wellman, Salaff, Dimitrova, Garton, Gulia, & Haythornthwaite, 2000), we could speak about computer-supported social networks. Or the unit of analysis could be an activity system, as proposed by Engeström (1987). 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 artifacts. All these units of analysis have been, individually, used in the studies that go under the label CSCL, the unit of analysis depending on the theoretical background and definitions of 'collaboration' used.

It is a challenging task to compare empirical studies conducted under the label CSCL, because they differ from each other in several significant aspects. First of all, there is no agreement whether one should study *effects of* or *effects with* CSCL. In 1991, Salomon, Perkins, and Globerson 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, as a result 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 analyzing learning in CSCL settings, researchers have used different learning tasks, and have studied how special concepts are learned (Roschelle, 1992). They have analyzed sociocognitive effects of CSCL (Järvelä, Hakkarainen, Lehtinen, & Lipponen, 2000), complex reasoning and levels of argumentation (Hoadley & Linn, 2000), explored science learning and inquiry processes (Edelson, Gordin, & Pea, 1999; Lipponen & Hakkarainen, 1997; Hakkarainen, Lipponen, & Järvelä, in press), collaborative knowledge building (Lipponen, 2000; Scardamalia, Bereiter, & Lamon, 1994), studied cognitive and metacognitive understanding (Brown, Ellery & Campione, 1998), design processes (Seitamaa-Hakkarainen, Raami, Muukkonen, & Hakkarainen, in press), and motivational aspects in CSCL (Hakkarainen, Lipponen, Järvelä, & Niemivirta, 1999). Lately, stress is also put on issues of participation (Guzdial & Turns, 2000; Lipponen, Rahikainen, Hakkarainen, & Palonen, 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, and is technology used for structuring the collaboration or to mediate collaboration (see, Hall, Miyake, & Enyedy, 1997; Hoadley, 1999; Dillenbourg, Eurelings, & Hakkarainen, 2001). There has already been mention of the differences in methodologies and units of analysis applied

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; Scardamalia, et al., 1994). But, 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 are these related to other aspects of CSCL, such as quality of students' discourse (but see Lipponen et al., 2001). As a consequence of the ambiguity (or richness if you will) of the empirical studies in the CSCL research, it is difficult to integrate the empirical studies and findings or to make any solid conclusions that some particular approach, instructional method, or application would give better results than some others. One does not know exactly the circumstances in which one set of results can be extended to another context.

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 (Järvelä, Bonk, Lehtinen, & Lehti, 1999; Roschelle, 1992). By contrast, collaboration through networked learning environments is still mainly based on written language. Thus, interaction taking 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).

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, or is it possible at all? There are some initial attempts to analyze this phenomenon in asynchronous CSCL environments (see Järvelä & Häkkinen, in press) 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, fact-oriented knowledge construction, short discussion threads with divergence topics, and unequal participation patterns (Guzdial & Turns, 2000; Lipponen et. al., 2001; Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2001). 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, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 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. 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.

Technology for collaboration

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 labeled 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'), such as CSILE (Computer Supported Intentional Learning Environment, see Scardamalia & Bereiter, 1994), 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, Tinker, Linn, Means, Brandsford, Roschelle, Hsi, Brophy, & Songer 1999, p. 33). Even if there exists a body of research with respect to CSCL applications, there is one crucial thing to remember. With respect to learning results, it is very hard to find solid evidence that some particular CSCL application is better than some other or better than some traditional classroom uses of computers.

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.

IMPLEMENTATION OF CSCL: FROM TECHNICAL INFRASTRUCTURE TO SOCIAL INFRASTRUCTURE

One of the major challenges of CSCL, or educational technology in general, is scaling-up; how to expand and implement the good practices that researcher and teachers have found and developed. In other words, what is needed in successful implementation of technology? Although technology, in some cases, may act as a "Trojan Mouse" (Papert, 1993) and serve as a catalyst for change, nowadays it seems very clear that technology itself does not necessarily make any deep changes in learning activities in school. Whilst creating new learning environments or learning communities, it is not just a matter of implementing and putting into use new technology but in many cases, also applying simultaneously new practices of learning and instruction.

In 1999 I proposed (Lipponen, 1999) that we should pay more attention to the factors that inhibit or support the implementation and use of CSCL at schools. To successfully implement and use CSCL in natural settings, one has to resolve technical, organizational, and pedagogical challenges. Bielaczyc (2001) has presented a parallel idea. According to her, one of the key factors in successful implementation of CSCL is to build an appropriate social infrastructure around the technical infrastructure. She proposed three levels of social infrastructure important for successful implementation and use of CSCL. These three include, cultural level (the philosophy and norms established among educators and students), activity level (practices), and tool level (technology). Thus, instead of focusing extensively on the technology, one should turn towards thinking about the social settings that support the implementation and use of technology.

Bielaczyc is right on the mark, but only partly. Namely, her model still appears to be slightly technology driven for it implies that the social infrastructure should be built around the technology; implicitly, the technological infrastructure appears to be the primary structure that is supported by some special social activities. I propose that we have two other advanced possibilities to think about this issue. First, one could explore and find the advanced and innovative pedagogical practices (or needs) that already exist in the particular context that aims to take technology in use. While these practices and activities are found, technology could be implemented to support and extend these already existing, good practices. In this case, the social infrastructure is primary to the technical infrastructure. An even more advanced idea would be to find the zone of proximal development of the particular community and to implement technology that has the potential to help to transform the community towards more advanced learning activities through an expansive learning cycle (Engeström, 1987). The third alternative is that technological and social infrastructure co-evolve. This is what happens, of course, in the

two previous alternatives too. But what I propose, is that the idea of co-evolution should be the starting point for thinking about implementing technology and new forms of learning activities. This approach is very much pedagogy and activity driven. It implies that technology should be very flexible and tailorable. Learners are not the same as the everyday people or experts, but need software designed especially for the learners. As far as I can see, the concept of social infrastructure has the potential to help us to think about the problems of implementing technology and building learning communities, and should be carefully studied in the future. There is one more thing to consider concerning infrastructures. Perhaps, as stated by Crook (1994), classrooms are still too neatly resourced for successful collaboration, and the material world is too often underestimated in building collaboration; material objects offer points of shared reference for developing genuine collaborative interactions.

CONCLUSIONS

In sum, even if the stress in CSCL research is on socially-oriented theories of learning, descriptive, observational, and non-experimental data, and methods from the fields of anthropology, communication science, and linguistic research, there is still no unifying and established theoretical framework, no agreed objects of study, no methodological consensus, or agreement about the concept of collaboration, or 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 more and more divergent lines. 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. Perhaps, as suggested by Hall (2001), researchers in the learning sciences should pay more attention to characterizing their work practices (their theory and method), that is, how to do this kind of research. According to Hall (2001), such efforts are important, for such efforts would help clarify how they theorize and investigate cognition, learning, and teaching, and teach newcomers how to do research.

I share the idea that appears on the homepage of the CSCL 2002 conference (http://www.cscl2002.org/intro.html): " … further progress is needed to provide a solid foundation for CSCL as a robust, effective research field. We [CSCL researchers] need to start to coalesce and strengthen a set of coherent foundations --without imposing a narrow approach or stifling the healthy interchange of conflicting interdisciplinary perspectives". This task is absolutely worthwhile of striving for. But as my exploration showed, it will also be a very demanding task, it might be even a mission impossible.

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