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## PRACTICES AND ORIENTATIONS OF COMPUTER-SUPPORTED COLLABORATIVE LEARNING

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### INTRODUCTION

In recent years, there has been a growing interest in computer-supported collaborative learning (CSCL) (Koschmann, 1996a; Lehtinen, Hakkarainen, Lipponen, Rahikainen, & Muukkonen, 1999; Koschmann, Hall, & Miyake, 2001). For many educators and researchers, CSCL appears to be one of the most promising ways, not only to promote, but also to achieve desired changes in teaching and learning practices.

Studies of technology-supported collaboration (or group work) are not new phenomena. They began in the late 1960s with the work of Doug Engelbart on supporting asynchronous collaboration among teams distributed geographically (see, for example Engelbart, 1973). This line of research, referred to as computer supported cooperative work (CSCW), has revealed how collective managing and sharing of knowledge within conventional and virtual teams and organizations can be supported by groupware (Coleman, 1999; Greenberg, 1991; Grudin, 1994). Partly, the inspiration for CSCL arose from this research on CSCW, and in a sense, CSCL is the younger sibling of CSCW.

On the other hand, the idea that collaboration is a basic form of human activity, essential for cultural development, and also a good way to learn, has been stressed by many writers throughout the history of psychology and education (Bruner; 1996; Engeström, 1987; Hutchins, 1995; Mead, 1934; Tomasello, 1999; Vygotsky, 1962; 1978). And the interest in group processes itself has a long history, at least in Western world, for instance, in social psychology (extensive reviews of group learning in educational context are found in Cohen, 1994; Dillenbourg, Baker, Blaye, and O'Malley, 1996; Webb & Palincsar, 1996). Thus, computer-supported collaborative learning is a field where technology meets psychology, and pedagogy. Instructional designers and software developers, educational psychologists, learning theorists, and computer scientists, are studying CSCL.

It was in 1996, when Koschmann (1996b) recognized computer-supported collaborative learning as an emerging paradigm of educational technology (O'Malley and Scanlon already used the term computer-supported collaborative learning in 1989). Whilst talking about computer-supported collaborative learning one typically refers to the acronym CSCL, and does not speculate what it might stand for. The short history of CSCL shows that there have been different interpretations and suggestions for the each individual word involved in CSCL (see Dillenbourg, 1999). For instance, the second "C" word is referred to as, collective (Pea, 1996), coordinated, cooperative and collaborative (see Koschmann, 1994). There have been even different interpretations of the meaning of the whole acronym. Recently, Koschmann (1999) referred to CSCL as computer support for collaboration *and* learning, suggesting that we should link research on learning and working more closely to each other, as well as the research on the CSCL and CSCW.

We believe that the conversation about the meaning of the acronym CSCL, or the individual words of the acronym has some relevance. This conversation is clearly related to the central theoretical and empirical questions concerning CSCL, such as, What is involved in studying collaboration supported by technology? and, What should we be studying? However, we are a little bit skeptical whether the speculation leads to any remarkable advancement in our field. We agree with Koschmann's (1994) proposal that "the best policy might be to simply use the acronym, allowing individual interpretation of what the letters might be (1994, p.220).

Nowadays, CSCL is an interdisciplinary research field 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. Following this line of thought, empirical CSCL research has focused on a great variety of issues. CSCL researchers have used various learning tasks, and have studied how special concepts are learned (Roschelle, 1992). They have investigated areas including perspective taking in CSCL interactions (Järvelä & Häkkinen, 2002), complex reasoning and levels of argumentation (Hoadley & Linn, 2000); they have explored science learning and inquiry processes (Edelson, Gordin, Pea, 1999; Hakkarainen & Sintonen, 2002), collaborative knowledge building (Lipponen, 2000; Scardamalia & Bereiter, 1994). They have conducted studies of cognitive and metacognitive understanding (Brown, Ellery & Campione, 1998), design processes (Seitamaa-Hakkarainen, Raami, Muukkonen, & Hakkarainen, 2001), motivational aspects in CSCL (Hakkarainen, Lipponen, Järvelä & Niemivirta, 1999; Veermans & Tapola, in press), and expansive transformations of activity systems (Engeström Y, Engeström, R, & Suntio, 2002). Lately, attention has also been given to issues of participation (Guzdial & Turns, 2000; Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003), sometimes focusing on gender differences in CSCL participation (Hakkarainen & Palonen, in press). Within these studies, there appears to be a rich variation in theories of learning and collaboration; in research design and procedure; in length of the study, numbers of participants, age, and whether students worked individually, in small groups, or in a community of learners.

Because of this diversity of empirical and theoretical research in the field of CSCL, more attention should be paid in making explicit the theories of learning and instruction that motivate the work and that underlie research designs. In other words, we CSCL investigators should characterize our work practices: clarify how we theorize and investigate cognition, learning, and teaching; and teach newcomers how to do CSCL research (Hall, 2001).

In this paper, we focus on several perspectives of learning that CSCL researchers and practitioners rely on, and how these perspectives affect our perceptions of associated research practices, collaboration, and technology. Specifically, we analyze practices and orientations of CSCL through three frameworks of learning: acquisition, participation and knowledge creation frameworks (see Hakkarainen, Palonen, Paavola, & Lehtinen, 2003; Paavola, Lipponen, & Hakkarainen, 2002). Each one of these frameworks appear to give rise to theoretical, methodological, and practical implications for CSCL research; core issues if we are to provide a solid foundation for CSCL research as a vigorous field.

Before we continue, we would like to remind the reader that the three frameworks of learning that we will present are not mutually exclusive; sometimes there is a thin line between them, and rigorous definitions are impossible. Thus, they should be interpreted more as ideal-typical illustrations about the main approaches that are found in CSCL.

### THREE FRAMEWORKS FOR UNDERSTANDING THE PRACTICES AND ORIENTATIONS OF CSCL

In 1998, Anna Sfard (1998) demonstrated two main lines of thinking about learning (and we would say also collaboration), namely, the acquisition and the participation frameworks (metaphors) of learning. Roughly speaking, the acquisition framework relies on a 'folk theory' of mind and learning; the commonly held view that people's behavior is determined, and can be accounted for by their beliefs and desires. In other words, in this framework human thinking is seen as akin to a computer performing formal operations on symbols (Bereiter, 2002; Engeström, 1987; Sfard, 1998). Within this line of thought, one would say that the mind is a container of knowledge, and learning is a process that fills the container, implanting knowledge there (for a recent criticism of the mind-as-a-container metaphor from the point of view of education, see Engeström, 1987, and Bereiter, 2002. The container idea of mind was, of course, criticized much earlier, for example by Dewey). Learning is considered as a matter of construction, acquisition, and outcomes, which are realized in the process of transfer; it consists in one's capability to use and apply knowledge in new situations. Knowledge is seen as a property and possession of an individual mind (see, Anderson, Greeno, Reder, & Simon, 2000; Anderson, Reder, & Simon, 1996; 1997; Greeno, 1997; Cobb & Bowers, 1999).

By contrast, in the background of the participation perspective is the approach of situated cognition that emphasizes how cognitive activities are always embedded in social and cultural contexts and cannot be understood in isolation (Brown, Collins,

& Duguid, 1989; Lave & Wenger, 1991). The participation framework is influenced by the renewed interest in the works of Soviet writers, especially Vygotsky and his sociocultural approach; and on the other hand, on Deweyian pragmatism (Sfard, 1998). These approaches appear to give appropriate tools for observing and conceptualizing the emerging forms of learning and work in our times, such as collaborative work in groups, and distributed expertise.

Our activities and environment, in a participation framework, are viewed as parts of a mutually constructed whole; the mind-world dualism is replaced by a part/whole relationship. Instead of studying the mental content of individual minds, the participation framework focuses on interaction, discourse, and participation processes emerging between and among particular community members or communities in particular, social and physical contexts (Lave 1988; Lave & Wenger, 1991). Terms such as acquisition and accumulation are supplemented, or in some cases, even replaced with others: discourse, interaction, activity, and participation. Cognition and knowledge are considered to be distributed over both individuals and their environments, and learning is "located" in these relations and networks of distributed activities of participation. As stated by Bruner (1991, p.3), "An individual's working intelligence is never 'solo'. It cannot be understood without taking into account his or her reference books, notes, computer programs and data bases, or most important of all, the network of friends, colleagues, or mentors on whom one leans for help and advice."

Knowledge does not exist either in a world on its own or in individual minds, but is an aspect of participation in cultural practices (Brown, Collins, & Duguid, 1989; Lave, 1988; Lave & Wenger, 1991). There are various terms for the manner and context of such participation: intact activity systems (Greeno, 1998), enculturation (Brown, et. al., 1989), guided participation (Rogoff, 1991), or legitimate peripheral participation (Lave & Wenger, 1991). This framework is not, in the first place, concerned not so much with individual learning, but rather with what emerges within the process of participation.

Within this framework, learning is not only a matter of epistemology, as it is in acquisition framework, but also a matter of ontology. Knowledge is not all that is constructed; humans and their identities are also considered to be constructions; learning is also a matter of personal and social transformation (Packer & Goicoechea, 2000). From this perspective, it follows that individual agent is not given, but rather emerges through collective activities (Wertsch, Tulviste & Hagstrom, 1993).

In the history of the learning sciences, and also of collaboration studies, the acquisition framework has been the prominent one. However, in the recent years, the participation framework has attracted considerable attention. If one reads through the recent papers published in CSCL research (e.g., Dillenbourg, Eurelings, & Hakkarainen, 2001; Stahl, 2002) one may easily get the impression that nowadays most of them rely on the participation framework. Is one then justified in concluding that these two frameworks capture all the aspects of CSCL research?

The answer might appear to be 'yes'. But one may say they are, in part, individually unsatisfactory, and what's more they are in direct conflict in respect of theory and methodology. It is time to consider approaches that do not much

resemble either of the two frameworks; these approaches are drawing more interest in the field of CSCL. The two most prominent representatives of what we consider as *knowledge creation* framework of learning (Paavola, Lipponen, & Hakkarainen, 2002) are Knowledge Building, proposed by Scardamalia and Bereiter (1994), and Engeström's (1987) model of Expansive Learning. Both these approaches address the same central question as their starting point: how is new knowledge or practices created through collaborative activities.

Bereiter (2002) argues that theories of learning that rely on the mind-as-container idea (e.g., acquisition framework), cannot say anything about knowledge that does not exist in the individual mind, and hence, are very limited in times when one speaks about knowledge-advancing organizations, and knowledge as product. The participation metaphor is not, according to Bereiter, any better. It tells how newcomers become 'oldcomers' by participating in cultural practices, but does not, however, say anything about how to go beyond best practices, or how new knowledge is created. As a solution to these dilemmas, and especially in considering how we should think about knowledge and education in the knowledge age, Bereiter (2002) offers the idea of *knowledge building*. Bereiter draws a theoretically clear distinction between knowledge building and learning. The concept of knowledge building refers to collective work for the advancement and elaboration of conceptual artifacts, such as theories, ideas and models, the entities of Popper's World 3 (i.e., the world of cultural knowledge; Popper, 1972). Learning, by contrast, is oriented towards changes in individual knowledge structures (or changes in Popper's World 2). Further, knowledge building goes beyond the participation metaphor, for it makes the distinction between the knowledge used in productive work practices, and the knowledge that is the object--and ultimately the product--of such work (Bereiter, 2002).

On the basis of cultural-historical activity theory (CHAT), Yrjö Engeström (1987; 1999) has developed the model of *expansive learning*. The basic tenet of CHAT is that human beings do not live in a vacuum, but our thinking and activities are mediated through the cultural symbol systems, artifacts we use, and social mediators, such as rules and division of labor (Engeström, 1987). The core of expansive learning is innovations: situations and action sequences in which actors attempt to go beyond the given, to achieve something that is not yet there, and to master their future. In the ideal-typical form, expansive learning embodies the following sequences (Engeström, 1999a): 1) questioning existing practices, 2) analyzing existing practices, 3) collaboratively building new models, concept, and artifacts for new practices, 4) examining and debating the created models, concepts and artifacts (material and immaterial), 5) implementing the models, concepts, and artifacts, 6) reflecting on and evaluating the process, and 7) consolidating the new practices. Through this expansive cycle, in which the actors focus on reconceptualizing their own activity system, shared objects of activity, and the relationship between them is the activity system transformed, and new motives and objects for the activity system created. In other words, a key aspect of expansive learning is that the agents negotiate a shared understanding of the new activities and artifacts, and in this process, something new is created and emerges.

Four core issues bind Bereiter and Engeström's approaches together and separate them from the acquisition and participation frameworks, though Bereiter and Engeström have their differences. Firstly, both authors try to understand how something new, whether it is practices or artifacts (conceptual or material), is invented. Bereiter emphasizes the difference between individually assimilated, already existing cultural knowledge and working deliberately for creating genuinely new knowledge. Activity theory makes a corresponding distinction between 'learning the given new' (i.e., transmitting culturally given knowledge to students typical of formal education) and 'learning the societal new' (Sutter, 2002). Both approaches try to explain how a community is able to transform, surpass, and expand their existing achievements through collaborative activities, and how these processes of innovation could be sustained.

Secondly, both authors stress the object relatedness of human activity. For Bereiter, the objects of collaborative activity are conceptual artifacts, the immaterial entities of Popper's World 3. Bereiter takes a pragmatic and naturalistic stance towards them. Although conceptual artifacts are immaterial, they are as real as objects of World 1. (The conception of abstract ideas as artifacts that have thing-like characteristics was proposed by Ilyenkov, 1977). In a similar vein, from Engeström's point of view, the object of activity can be a material thing, but it can also be less concrete, such as a model or even a common idea, as long as it can be shared for manipulation and transformation by the participants of the activity (Kuutti, 1996). Within the frames of Wartofsky's (1979) historical epistemology, on which Engeström (1987) centrally relies, abstract artifacts are seen as evolved from artifacts used in our primary productive, social, and linguistic practices. Hence, artifacts are subject to continuous transformation, rather than being essentially stable and fixed.

Objects of activities should not be confused with goals or aims (Engeström, 1987). Goals and aims are related to individual actions and thus are more as elements of acquisition, whereas objects are always related to collective activities. For both authors, objects work as objects that one can reflect on, but they also work as tools for mediating and coordinating collaborative activities. Bereiter and Engeström stress the idea that achieving and working on objects is a collaborative endeavor, where ideas are expressed and mediated through a rich variety of representational tools, such as language, computers, ideas, models, and so on, in order to achieve something that does not yet exist.

Thirdly, both of the approaches highlight the mediated nature of the knowledge creation process: collaborative activities are organized around shared objects rather than take place through immediate interaction between participants. While Bereiter's theory of knowledge building emphasizes the importance of engaging in dialogue with conceptual artifacts created by the participants, Engeström's approach addresses models and visions emerging from reflections on disturbances and contradictions of material practices. Following Wartofsky's (1979) terminology, these models and visions are symbolic representations (secondary and tertiary artifacts) emerging from tools and practices (primary artifacts). Many prevailing accounts of CSCL appear to ignore the mediated nature of collaboration. Mediation is missing, for instance, when collaborative learning is defined as taking place in

“collaborative situations” that involve “collaborative interactions”, “collaborative processes” and collaborative effects (Dillenbourg, 1999); in such an account, the objects’ articulation shaped by the collaborators in the first place, does not have any place. Presumably, because of the influence of the participation perspective discussed above, investigators tend to reduce collaboration to interactive moments and disappearing traces of knowledge.

Fourthly, even if both approaches, knowledge building and expansive learning, stress the importance of the collaborative activities, both also emphasize individual activities; not individuals separately, but individuals acting as a part of social stream of activities. In highlighting coevolution of individuals and collectives, these approaches help to overcome the dichotomy of individualistic acquisition perspectives and participatory approaches that take expertise and competence as exclusively residing in cultural practices and tools.

#### FROM STUDYING LEARNING OUTCOMES AND PARTICIPATION TO STUDYING KNOWLEDGE CREATION

The three frameworks of learning, acquisition, participation, and knowledge creation, naturally have implications regarding how to do CSCL research. One can say that the acquisition framework, whilst studying the mental content of individual minds, relies strongly on the tradition of experimental research design. The applied unit of analysis has mainly been an individual or a dyad. Whether learning takes place or not can be measured experimentally with the pre-post test design without paying much attention to the social and cultural conditions of learning. Studies within the acquisition framework are mainly designed to evaluate learning outcomes and the efficacy of CSCL. These studies have revealed that group work generally leads to better learning outcomes than individual work (see Dillenbourg, et al., 1996). Hence, if one relies on the acquisition framework, one mainly studies the *effects of CSCL*, that is, what participants have learned and can transfer from those situations to working with others and computers (see Salomon, Perkins, & Globerson, 1991).

In the participation framework, theory and practice are tightly linked; learning and cognition are studied in order to influence, for instance, classroom practices. The participation framework has involved adopting a variety of methods from such fields of anthropology, communication science, and linguistic research. Typical methods for analyzing cultural practices and discourse are ethnographical methods and discourse analysis with descriptive, observational, and non-experimental data. In contrast to acquisition that studies human cognition with experimental design and in laboratory-like settings, participation research is conducted also in “real world contexts”, for instance, at schools. Stress is put on the ecological validity of the research. Putting these methodological ideas in the context of CSCL, one may speak of studying *effects with CSCL*, referring to processes people and computers achieve in synergy (Kolodner & Guzdial, 1996; Salomon et al., 1991).

It appears that the participation framework guides investigators to examine CSCL in terms of short interactive episodes in which people struggle to create common ground and achieve mutual understanding. People make sense of the world through immediate interaction with the material and cultural world. In order to understand the nature of interactive episodes, people often describe the physical environment in which the interaction takes place in much detail, including those regarding the physical artifacts (e.g., computer tools) that the participants rely on. By carefully examining advancement of interactions, it may be possible to capture a genuine moment of collaboration or mutual construction of knowledge. Detailed investigations of discourse processes help the CSCL research community to understand with substantial, deep, complex, interactive processes of joint activity between the participants. By focusing on these immediate interactions, investigators intend to examine how the participants make sense of each other through grounding and negotiation. It is often assumed that there is not knowledge between minds in a strong sense, only ‘traces of knowledge’ and situated understanding. These studies, of course, are valuable. Without carefully investigating immediate interactive processes involved in collaborative activity, it would be very difficult to understand human activity in general and CSCL in particular. Nevertheless, these approaches appear to rely on somewhat problematic epistemological and ontological assumptions when considered in respect of knowledge-creation processes. It is assumed that meanings are indexical in nature, and, thereby, intrinsically bound to here and now situations; in the emerging knowledge society, this kind of phenomenological reductionism does not take investigators very far. Although investigators relying on the participation framework sometimes talk about the role of mediating artifacts in intelligent activity, this approach does not appear to be able to adequately capture the dialectics of mediation due to its tendency to reduce the whole process to immediate interactive episodes, individual situations, and situationally bound practices.

Methodologically, the knowledge creation framework relies on the idea of *design research* (Bereiter, 2002; Collins, 1999), or *the methodological cycle of expansive developmental research* (Engeström, 1987). These two approaches have several aspects in common. First, what defines these methodological approaches is purpose; besides understanding the existing state of knowledge and practise, sustaining transformation and innovation. Secondly, both contain the idea that research should be carried out in close collaboration with practitioners. Thirdly, research is definitely interventionist, and focuses on transformations rather than just on current practices or knowledge. Fourthly, formulated on the basis of accurately perceived shortcomings, contradictions, and constraints of the present situation, both approaches aim at creating innovations, and in doing so, research is guided by some vision or awareness of potential. In both cases, the findings are fed back into the system for further cycles of expansion. In addition to these four methodological ‘principles’, Engeström strongly stresses the historical analysis of a particular activity system in question in order to find the inner contradictions of it.

A good example of the realization of these methodological ideas is a “change laboratory” developed by Engeström (1999b). For feeding back the results into the activity system, and making the contradictions visible, Engeström developed an

intervention method called the “change laboratory”, which is an inseparable part of his developmental research method. The core idea of “change laboratory” is to guide practitioners to collaboratively reflect on their activities with the help of researchers.

The knowledge-creation perspective calls for investigation of sustained processes of working for creating new knowledge or transforming social practices. It guides one to investigate boundaries of various activity systems (teachers, students, larger school community, local communities). Knowledge creation appears to take place in heterogeneous networks that consist of agents and their communities as well as physical and conceptual artifacts (Latour, 1999; Miettinen, 1999). These artifacts can be seen as dynamic and active participants of interaction rather than just end results of learning process, so that the dialogue does not only take place between minds. It appears that this line of investigation requires an extensive timescale and does not attend to only a few collaborative moments (Lemke, 2001). Consequently, it is necessary to zoom out from doing microanalytic processes of interaction to examine long-standing processes of working for advancement of knowledge and associated individual and social transformations. In the knowledge creation framework, the unit of analysis can, for instance, be the activity system, as it is in the case of expansive learning.

In sum, even this short look to the CSCL methodology indicated that, to date, there is much disagreement, in several key areas, about how to conduct CSCL research: what methods to apply, what should be the units of analysis (individuals, dyads, groups, communities, activity system, network of activity systems, conceptual artifacts), and which approach--zoom-in or zoom-out--should be applied to observed interaction situations. A great variety of approaches, mainly individualistic, has been used in the studies that go under the label CSCL. In respect of units of analysis, the knowledge creation framework allows escape from the very serious problem of the acquisition and participation frameworks.

#### INTERNALIZING, INTERACTING, OR TRANSFORMING: COLLABORATION FROM THE PERSPECTIVE OF THREE FRAMEWORKS

Whether one relies on the acquisition, participation, or knowledge creation framework, the central form of activity in these approaches is collaboration. But before discussing collaboration, and why it is considered important, it is appropriate to ask, What is it?

Traditionally, there exist two main theoretical perspectives on collaboration, which trace back to the thinking of Piaget and Vygotsky. 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 performs together. Among researchers, however, including those in academic fields, the term 'collaboration' and its value are understood rather differently.

Approaches that rely heavily on the idea of intersubjectivity or internalization are best interpreted in the framework of the acquisition. Consider the concept of sociocognitive conflict proposed by the neo-Piagetian researchers (see for instance,

Doise & Mugny, 1984). The cognitive value of collaboration is based on a process in which emerging socio-cognitive conflicts create a state of disequilibrium. For instance, agents at 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 in 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, but still representing an acquisition framework, 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). Both these Piagetian approaches represent the acquisition metaphor of learning; they are interested in individual knowledge gain or development.

Vygotsky’s ideas related to collaboration have also been, in the CSCL research, understood in various ways. Some interpret Vygotsky’s ideas very traditionally: that cultural processes give rise to individual cognition, and collaboration is a source or facilitator of individual learning (see Salomon & Perkins, 1998; Sfard, 1998). This view assumes that because of engagement in collaborative activities, individuals can master something they could not do before the collaboration. In other words, collaboration is interpreted as a facilitator of individual cognitive development. Essentially this is an acquisition approach, despite the social dimension. Put briefly, one would say that from the acquisition perspective, collaboration is a form of interaction from which humans gain knowledge and new competencies by internalizing.

On the other hand, taking a more contextual view (Cole and Wertsch, 1996) Vygotsky’s concepts can be interpreted as antecedents of distributed cognition and situated learning (“...because what we call mind works through artifacts it cannot be unconditionally bounded by the head or even the body...it must be seen as distributed in the artifacts, p. 253); and these approaches are essentially based on participation. Such an interpretation of Vygotsky’s ideas emphasizes the role of mutual engagement and co-construction of knowledge, learning being more 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).

In the participation framework, one finds some other, similar approaches: collaboration can be, for instance, “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” (Brufee, 1993, p.3). Or, in a community of learners, as proposed by Brown and Campione (1996), 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".

What then would collaboration be from the point of view of knowledge creation framework? The basic point is that knowledge creation framework tries to go beyond the Piagetian and Vygotskian ideas, and in so doing, expand our understanding of the concept, and the phenomena of collaboration.

To clarify this issue, let us give an example. A seldom cited, but very interesting categorization of types of collaborative activities has been made by Engeström (1992). On the basis of Fichtner's (1984) ideas, Engeström elaborated a three-level notion of developmental forms of collaboration; 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 (cf. acquisition framework). In 'cooperative' interactions, says Engeström, actors focus on a shared problem, trying to find mutually acceptable ways to conceptualize it (cf. participation framework; even if this example refers to a shared object of work, it does not stress the conscious development of the object as knowledge creation framework does). The third form of interaction is reflective communication (cf. knowledge creation framework), in which the actors focus on reconceptualizing their own interaction system in relation to their shared objects of and scripts of activity; both, the objects and the scripts are reconceptualized. In other words, an important aspect of this transformation is the ability to make metacomunicative statements, this is, discriminate between object and tool. 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 not only forms of collaboration, but also a natural cycle of any genuine learning activity.

In the context of knowledge building (Bereiter, 2002; Scardamalia, 2002), collaboration is considered as progressive discourse. Characteristic of progressive discourse in a particular community are mutual advances in understanding, empirical testability, expanding the basis for discussion, and openness. The overall focus of progressive discourse is on pursuing understanding and on seeing knowledge as problematic, as something that needs to be explained. Cognitive risks are allowed, that is, errors and misconceptions are seen as possibilities for development, not as something to avoid. In this process, participants set forth their ideas and negotiate a fit between personal ideas and ideas of others. Driving forces are idea diversity and idea contrasts. In other words, one might say that the contradictions between and among conceptual artifacts in progress set the dynamics for collaboration.

Relying on Charles S. Peirce's philosophy, on knowledge building, and on activity theory, Paavola and Hakkarainen (2003) argue that in the knowledge creation framework, collaboration can be considered as a process mediated by

shared objects on which the participants are working. It cannot be satisfactorily characterized as a certain type of situation, a certain kind of interaction between minds, a certain process, or a certain effect. These aspects of activity are involved in collaboration, but the defining characteristic of creative collaboration is that it is focused on advancing certain shared objects, knowledge-laden or conceptual artifacts and the agents' relationship to them. Creative collaboration is also distributed across time and requires a relatively long timescale. Rather than zooming in collaborative moments in collaborative situations, it appears to be essential to zoom out from an individual situation to the developmental history of its formation, as well as the unfolding and elaboration of the objects of collaborative activities across extended periods of time.

If one tries to understand and explain collaboration only through the acquisition framework, one falls in the following dilemma: if collaboration is understood as a form of interaction leading to individual knowledge gain, an approach to collaboration solely in terms of individual gains, appears to be very limited approach to CSCL. For nowadays, it is very common to speak about collaboration taking place between communities or organizations, or activity systems. Especially the knowledge creation framework gives us the idea that it is important to understand that collaboration does not just happen between individuals or small groups (which still appears to be the mainstream approach in CSCL), but also within and between organizations and activity systems (Engeström, 2001) that have at least partially shared objects of activity.

Whether one is talking about an individual student, their team or a learning community, the focus of the acquisition framework is on relatively closed systems. From the point of view of the knowledge creation framework, it is reasonable also to address the complex relations between various activity systems, especially focusing on processes in which people and artifacts break traditional boundaries (boundary object, Star, 1989). A great deal of reified knowledge and experience comes from the larger body of cultural knowledge (e.g., a general strategy of knowledge management) so that it has to be tailored and fitted into the local practices in order to be useful. Some of these artifacts, such as shared external representations of a problem or domain (e.g., forms used to structure activities or categorize products) are boundary objects. According to Star, "boundary objects are objects that are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites ... Like the blackboard, a boundary object 'sits in the middle of a group of actors with divergent viewpoints'"(Star, 1989, p. 46; cf. Engeström, Y., Engeström, R., & Kärkkäinen, 1995, p. 322).

In the participation framework, it is very common that the meanings attached to collaboration are mainly very positively loaded, or the collaborative settings are interpreted very narrowly referring only to positive phenomenon. From the knowledge creation perspective, collaborative situations are also full of contradictions, disturbances, breakdowns, competition, conflicts and so on (Engeström, 1987; 1992; Kling, 1991; Kramer, 1999). Knowledge creation does not just rely on 'cold' cognition but also requires 'hot' cognition (Kunda, 1999) both in terms of a deep personal commitment to pursue a chosen line of inquiry and in terms

of involving inter-subjective tensions. Sharing of knowledge and expertise is a hard and labor-intensive process (Coleman, 1999). Pursuit of new knowledge and social transformations requires significant resources of time and sustained efforts, and often forces all the participants to change their practices. Consequently, tensions and disturbances of prevailing practices are unavoidable. From the perspective of social transformation, however, contradictions are sources of development, and in this sense, their emergence is a natural part of any learning cycle that produces something new. Contradictions are driving forces of development. An activity system is almost continuously dealing with contradictions, and trying to solve them (Engeström, 1987; Kuutti, 1996).

#### STRUCTURING, ESTABLISHING OR TRANSFORMING: THE ROLE OF TECHNOLOGY

Technology is one central element of CSCL development and research. There are some relatively straightforward points that may be made about CSCL applications. Firstly, there exists a great variety in the technologies used in CSCL research, and with respect to learning results, it is very difficult to find evidence that some particular CSCL application is better than some other. Secondly, there is no established way to classify the variety of tools that might be considered as collaborative (Lipponen & Lallimo, 2003). Thirdly, almost any technological application, could, in some way, be used in support of collaboration, i.e., by people working together on something. Instead of addressing these three issues, we think that more interesting and important questions related to CSCL technology are, What are the purposes sought with technology? and For what purposes is technology used?

To sharpen the argument a bit, one would say that in the acquisition framework technology is considered as a powerful tool that will in and of itself improve teaching and learning. Consequently, what we need are curricula to help students learn how to make use of the new tools. Thus, the primary issues are access and training, and not much interest is directed to what students think about technology, or what purposes and how students are supposed to use technology. In other words, while working with technology, the core issue is how, not whether (Bruce, 1996). CSCL technology is implemented “as a well-defined plan of action, often accompanied by associated objects, such as teacher guides, student texts, and new technologies” (Bruce and Peyton 1990, p.172). This approach represents the idea of reproduction of the idealization of the technology. In this framework, technology is mainly used for structuring collaboration, and in a sense, technology sets the rules or frames for how learning takes place. Examples of the acquisition framework are studies where student dyads are assigned to work together at the computer, and to solve a given problem.

In the participation framework, technology can be considered as social practice. This means that technology is understood within the sites and in the relations of its everyday use (Suchman, Blomberg, Orr, & Trigg, 1999). It is ‘invented’ in everyday

uses by the agents, and the locus of these activities is a community of practice. In other words, in contrast to the acquisition view that considers technology as a well-defined plan of action, the participation framework considers that technology is *re-created* by, for instance, the teachers and students who actually use it (Bruce and Peyton, 1990, p. 171; Nardi & O'Day, 1999). From this point of view, technology is much more than functionality. Even if it exists with an implicit model of use, the construction and use of technology requires construction of meaning that evolves in the everyday uses of technology (Tuomi, 2002); technology exists as technology-in-use. Further, Bruce (1996), in considering how technology is constructed, has pointed out that not only are the meanings of these artifacts socially constructed, but their physical designs as well. Thus, technologies are not merely tools with fixed meanings, rather, they are imbued with intentionality and meaning. Following this line of thought, in an educational context, one should be interested in what meanings students attach to technology, and how technology is used in everyday school practices. Technology is not used as a tool for structuring collaboration, but as a tool to support, more than to change, the already existing practices. Within this framework learning is also, as it were, a matter of ontology; technology (such as CSCL environments) not only provides a space for sharing knowledge and cognitive achievements, but also spaces for the participants to "author" themselves (Holland, Lachicotte, Skinner & Cain, 1998, p. 169). Very much research remains to be done in this approach that considers technology as social practice (but see Bruce, 1996). In the knowledge creation framework, besides the elements already mentioned, technology has other essential dimensions: it is considered as a mediating tool or transformative artifact that helps to facilitate expansive cycles of learning. The central concerns are, What is the additional value of some particular technology? and How can it be used to transform collaborative activities? According to this line of thinking, one could begin implementation of technology in several ways. 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. As these practices and activities are found, technology could be implemented to support and transform these already existing, good practices. Second, an even more advanced approach would be to find the zone of proximal development of the particular community and to put in place technology that has the potential to help transform the community towards more advanced activities, through an expansive learning cycle (Engeström, 1987; Lipponen, 2001). Third, technology and social practices could co-evolve. 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 them (Bruce & Peyton, 1993; Lipponen, 2001). It is as a mediating or transformative tool that technology is used in advanced CSILE studies (see Scardamalia & Bereiter, 1994), where collaborative application is used to mediate knowledge building activities among students.

CONCLUSIONS

In this paper, we have analyzed the practices and orientations of CSCL through three frameworks of learning; acquisition, participation and knowledge creation. As shown, each one of these frameworks poses theoretical, methodological, and practical implications for CSCL research. These issues cannot be neglected if we are to provide a solid foundation for CSCL as a robust research field. To summarize the ideas we have presented so far in this paper, we ask the readers to turn to table 1. In table 1 is presented the main features of each framework.

*Table 1. Basic features of acquisition, participation, and knowledge creation frameworks*

	<i>Acquisition</i>	<i>Participation</i>	<i>Knowledge creation</i>
Educational focus	Domain-specific knowledge structures	Enculturation, identity formation	Knowledge building, expansive learning, innovation
Foundations	Theories of knowledge structures and schemata	Situated and distributed cognition	Theories of creating and building knowledge, and expansive learning
Collaboration	Facilitator of individual cognition	Legitimate peripheral participation	Transformative activity
Technology	Structuring artifact	Social practice	Meditational and transformative artifact
Methodology	Pre-post tests, Laboratory experiments	Ethnographical methods and discourse analysis with descriptive, observational, and non-experimental data. Ecological validity	Design research, expansive developmental research

Computer-supported-collaborative learning is an emerging paradigm of educational technology. Even if the stress in CSCL research is on socially-oriented theories of learning, or theories of knowledge creation, one can conclude, on the

basis of our analysis that there is still no unifying and established theoretical framework, no agreed objects of study, no methodological consensus, or agreement about the unit of analysis (this is of course, the challenge of many other disciplines as well), or no established way to classify the variety of tools that might be considered as CSCL tools. Thus, it is also 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 in the context of CSCL. One does not know exactly the circumstances in which one set of results can be extended to another context.

Imagine that you would have to describe the present practices and orientations of CSCL, with only one word. What would that word be? Diversity or richness, we would say. Positively considered, the richness is essential for the advancement of the CSCL field just as biodiversity is essential to the success of an ecosystem. As aptly pointed out by Scardamalia (2002), it may be that idea diversity creates an environment where ideas develop into new and more cultivated forms. Negatively interpreted, it seems that the CSCL field is proceeding along more and more divergent lines.

The richness also has its consequences. One is that many of the technical, theoretical, and pedagogical insights of CSCL have not been transformed into widely adopted practices of teachers and students. As pointed out by Lehtinen and others (Lehtinen et al., 1999) the theories and practices of CSCL may still be too immature to be widely applied in educational settings. Hence, there is a need for theoretical as well as practical understanding of CSCL, and theoretically well grounded development of CSCL tools, which are adequately embedded in a practical educational context. On the other hand, there is evidence that marriage of CSCL technology and new theories of learning and instruction has begun to have an impact on the quality of teaching and learning. We can see an increasing number of teachers and students around us starting to work with CSCL environments applying new pedagogical practices. Partly this is, of course, a consequence of the zeitgeist, partly teachers' own advancement. But--and this is our strong impression--we can see also trails of our work, ideas growing from CSCL research and thinking.

In the future, and as the field matures, one of the central challenges is, how to deal with the diversity. Should we be seeking, consistently, a consensus and a more limited set of labels, theories, and methods to make the field more unified. Or do we even need an agreed interpretation of CSCL research, and should we just accept the diversity, and let the future determine which practices and orientations will survive? (The challenge of diversity is not just our challenge, but strongly related to the diversity of the whole field of the learning sciences).

If one is to believe Anderson, Reder, and Simon (representatives of the acquisition camp), and Greeno, (advocate of the participation camp), researchers on learning sciences are in consensus, accepting that wide approach is essential for understanding human learning (Anderson, et al., 2000). What researchers need to do in the future in the learning sciences is to progress towards reconciling the cognitive and the social approaches (see, Schoenfeld, 1999).

There already exist initial attempts to deal with the diversity, and integrate individual and collective, cognitive and social aspects of learning such as, 'emergent

perspective' (Cobb & Yackel), "in which learning is a constructive process that occurs while participating in and contributing to the practices of the local community" (p. 185). Another idea for reconciliation is suggested by Greeno and others (Greeno & The Middle School Mathematics Through Applications Project Group, 1998). They pursued the idea of 'functional analysis of intact activity systems'. These are systems, "in which people interact with each other and with material, informational, and conceptual resources in their environments" (p. 23). However, these attempts at synthesis are not entirely satisfactory; they still very strongly rely only on the participation framework.

The knowledge-creation framework we propose is offered as a way of rising above, and solving the intractable difficulties in and between acquisition and participation frameworks. Even if the knowledge-creation framework stresses the collaborative activities, individual activities are also emphasized; not individuals separately, but as a part of social stream of activities.

Whether the attempts at combining different frameworks in order to deal with the diversity will have any success one does not yet know. Simultaneously, we have to cope with the practical challenges of CSCL: to utilize all the possibilities it offers and to develop more innovative technology and advanced pedagogical and cognitive practices that are achievable to teachers and students. To meet the challenge, educators, researchers and software developers definitely need to know more about how students and teachers are working with CSCL. We are at the very beginning of a fundamental change in education and still know too little about technology-supported collaboration.

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