

Computer-supported collaborative learning: An historical perspective

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Computer-supported collaborative learning (CSCL) is an emerging branch of the learning sciences concerned with studying how people can learn together with the help of computers. As we will see in this essay, such a simple statement conceals considerable complexity. The interplay of learning with technology turns out to be quite intricate. The inclusion of collaboration, computer mediation and distance education has problematized the very notion of learning and called into question prevailing assumptions about how to study it.

Like many active fields of scientific research, CSCL has a complex relationship to established disciplines, evolves in ways that are hard to pinpoint and includes important contributions that seem incompatible. The field of CSCL has a long history of controversy about its theory, methods and definition. Furthermore, it is important to view CSCL as a vision of what may be possible with computers and of what kinds of research should be conducted, rather than as an established body of broadly accepted laboratory and classroom practices. We will start from some popular understandings of the issues of CSCL and gradually reveal its more complex nature. We will review CSCL's historical development and offer our perspective on its future.

CSCL within education

As the study of particular forms of learning, CSCL is intimately concerned with education. It considers all levels of formal education from kindergarten through graduate study as well as informal education, such as museums. Computers have become important in this, with school districts and politicians around the world setting goals of increasing student access to computers and the Internet. The idea of encouraging students to learn together in small groups has also become increasingly emphasized in the broader learning sciences. However, the ability to combine these two ideas (computer support and collaborative learning, or technology and education) to effectively enhance learning remains a challenge—a challenge that CSCL is designed to address.

Computers and education

Computers in the classroom are often viewed with skepticism. They are seen by critics as boring and anti-social, a haven for geeks and a mechanical, inhumane form of training. CSCL is based on precisely the opposite vision: it proposes the development of new software and applications that bring learners together and that can offer creative activities of intellectual exploration and social interaction.

CSCL arose in the 1990s in reaction to software that forced students to learn as isolated individuals. The exciting potential of the Internet to connect people in innovative ways provided a stimulus for CSCL research. As CSCL developed, unforeseen barriers to designing, disseminating and effectively taking advantage of innovative educational software became more

1 and more apparent. A transformation of the whole concept of learning was required, including
2 significant changes in schooling, teaching and being a student.

3 **E-learning at a distance**

4 CSCL is often conflated with e-learning, the organization of instruction across computer
5 networks. E-learning is too often motivated by a naïve belief that classroom content can be
6 digitized and disseminated to large numbers of students with little continuing involvement of
7 teachers or other costs, such as buildings and transportation. There are a number of problems
8 with this view.

9 First, it is simply not true that the posting of content, such as slides, texts or videos, makes for
10 compelling instruction. Such content may provide important resources for students, just as
11 textbooks always have, but they can only be effective within a larger motivational and interactive
12 context.

13 Second, online teaching requires at least as much effort by human teachers as classroom
14 teaching. Not only must the teacher prepare materials and make them available by computer, the
15 teacher must motivate and guide each student, through on-going interaction and a sense of social
16 presence. While online teaching allows students from around the world to participate and allows
17 teachers to work from any place with Internet connectivity, it generally significantly increases
18 the teacher effort per student.

19 Third, CSCL stresses collaboration among the students, so that they are not simply reacting in
20 isolation to posted materials. The learning takes place largely through interactions among
21 students. Students learn by expressing their questions, pursuing lines of inquiry together,
22 teaching each other and seeing how others are learning. Computer support for such collaboration
23 is central to a CSCL approach to e-learning. Stimulating and sustaining productive student
24 interaction is difficult to achieve, requiring skillful planning, coordination and implementation of
25 curriculum, pedagogy and technology.

26 Fourth, CSCL is also concerned with face-to-face (F2F) collaboration. Computer support of
27 learning does not always take the form of an online communication medium; the computer
28 support may involve, for instance, a computer simulation of a scientific model or a shared
29 interactive representation. In this case, the collaboration focuses on the construction and
30 exploration of the simulation or representation. Alternatively, a group of students might use a
31 computer to browse through information on the Internet and to discuss, debate, gather and
32 present what they found collaboratively. Computer support can take the form of distant or F2F
33 interaction, either synchronously or asynchronously.

34 **Cooperative learning in groups**

35 The study of group learning began long before CSCL. Since at least the 1960s, before the advent
36 of networked personal computers, there was considerable investigation of cooperative learning
37 by education researchers. Research on small groups has an even longer history within social
38 psychology.

39 To distinguish CSCL from this earlier investigation of group learning, it is useful to draw a
40 distinction between *cooperative* and *collaborative* learning. In a detailed discussion of this
41 distinction, Dillenbourg (1999a) defined the distinction roughly as follows:

1 In cooperation, partners split the work, solve sub-tasks individually and then assemble the
2 partial results into the final output. In collaboration, partners do the work ‘together.’ (p. 8)

3 He then referred to Roschelle & Teasley’s (1995) definition of collaboration:

4 This chapter presents a case study intended to exemplify the use of a computer as a
5 cognitive tool for learning that occurs socially. We investigate a particularly important
6 kind of social activity, the *collaborative construction of new problem solving knowledge*.
7 Collaboration is a process by which individuals *negotiate and share meanings* relevant to
8 the problem-solving task at hand.... Collaboration is a coordinated, synchronous activity
9 that is the result of a continued attempt to construct and maintain a shared conception of a
10 problem. (p. 70, emphasis added)

11 If one is researching learning, this is a significant contrast. In cooperation, the learning is done
12 by individuals, who then contribute their individual results and present the collection of
13 individual results as their group product. Learning in cooperative groups is viewed as something
14 that takes place individually—and can therefore be studied with the traditional
15 conceptualizations and methods of educational and psychological research.

16 By contrast, in the Roschelle & Teasley characterization of collaboration, learning occurs
17 socially as the collaborative construction of knowledge. Of course, individuals are involved in
18 this as members of the group, but the activities that they engage in are not individual-learning
19 activities, but group interactions like negotiation and sharing. The participants do not go off to do
20 things individually, but remain engaged with a shared task that is constructed and maintained by
21 and for the group as such. The collaborative negotiation and social sharing of *group meanings*—
22 phenomena central to collaboration—cannot be studied with traditional psychological methods.

23 **Collaboration and individual learning**

24 As we have just seen, collaborative learning involves individuals as group members, but also
25 involves phenomena like the negotiation and sharing of meanings—including the construction
26 and maintenance of shared conceptions of tasks—that are accomplished interactively in group
27 processes. Collaborative learning involves individual learning, but is not reducible to it. The
28 relationship between viewing collaborative learning as a group process versus as an aggregation
29 of individual change is a tension at the heart of CSCL.

30 Earlier studies of learning in groups treated learning as a fundamentally individual process. The
31 fact that the individuals worked in groups was treated as a contextual variable that influenced the
32 individual learning. In CSCL, by contrast, learning is also analyzed as a group process; analysis
33 of learning at both the individual and the group unit of analysis is necessary. This is what makes
34 CSCL methodologically unique, as we shall see later in this essay.

35 To some extent, CSCL has emerged in reaction to previous attempts to use technology within
36 education and to previous approaches to understand collaborative phenomena with the traditional
37 methods of the learning sciences. The learning sciences as a whole have shifted from a narrow
38 focus on individual learning to an incorporation of both individual and group learning, and the
39 evolution of CSCL has paralleled this movement.

The Historical Evolution of CSCL

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The beginnings

Three early projects—the ENFI Project at Gallaudet University, the CSILE project at the University of Toronto, and the Fifth Dimension Project at the University of California San Diego—were forerunners for what was later to emerge as the field of CSCL. All three involved explorations of the use of technology to improve learning related to literacy.

The ENFI Project produced some of the earliest examples of programs for computer-aided composition or “CSCWriting” (Bruce & Rubin, 1993; Gruber, Peyton, & Bruce, 1995). Students who attend Gallaudet are deaf or hearing impaired; many such students enter college with deficiencies in their written-communication skills. The goal of the ENFI Project was to engage students in writing in new ways: to introduce them to the idea of writing with a ‘voice’ and writing with an audience in mind. The technologies developed, though advanced for the time, might seem rudimentary by today’s standards. Special classrooms were constructed in which desks with computers were arranged in a circle. Software resembling today’s chat programs was developed to enable the students and their instructor to conduct textually-mediated discussions. The technology in the ENFI project was designed to support a new form of meaning-making by providing a new medium for textual communication.

Another early, influential project was undertaken by Bereiter and Scardamalia at the University of Toronto. They were concerned that learning in schools is often shallow and poorly motivated. They contrasted the learning that takes place in classrooms with the learning that occurs in “knowledge-building communities” (Bereiter, 2002; Scardamalia & Bereiter, 1996), like the communities of scholars that grow up around a research problem. In the CSILE Project (Computer Supported Intentional Learning Environment), later known as Knowledge Forum, they developed technologies and pedagogies to restructure classrooms as knowledge-building communities. Like the ENFI Project, CSILE sought to make writing more meaningful by engaging students in joint text production. The texts produced in each case were quite different, however. The ENFI texts were conversational; they were produced spontaneously and were generally not preserved beyond the completion of a class. CSILE texts, on the other hand, were archival, like conventional scholarly literatures.

As was the case for CSILE, the Fifth Dimension (5thD) Project began with an interest in improving reading skills (Cole, 1996). It started with an after-school program organized by Cole and colleagues at Rockefeller University. When the Laboratory of Comparative Human Cognition (LCHC) moved to UCSD, the 5thD was elaborated into an integrated system of mostly computer-based activities selected to enhance students’ skills for reading and problem solving. The “Maze,” a board-game type layout with different rooms representing specific activities, was introduced as a mechanism for marking student progress and coordinating participation with the 5thD. Student work was supported by more-skilled peers and by undergraduate volunteers from the School of Education. The program was originally implemented at four sites in San Diego, but was eventually expanded to multiple sites around the world (Nicolopoulou & Cole, 1993).

All of these projects—ENFI, CSILE and 5thD—shared a goal of making instruction more oriented toward meaning making. All three turned to computer and information technologies as resources for achieving this goal, and all three introduced novel forms of organized social

1 activity within instruction. In this way, they laid the groundwork for the subsequent emergence
2 of CSCL.

3 **From conferences to a global community**

4 In 1983, a workshop on the topic of “joint problem solving and microcomputers” was held in
5 San Diego. Six years later, a NATO-sponsored workshop was held in Maratea, Italy. The 1989
6 Maratea workshop is considered by many to mark the birth of the field, as it was the first public
7 and international gathering to use the term “computer-supported collaborative learning” in its
8 title.

9 The first full-fledged CSCL conference was organized at Indiana University in the fall of 1995.
10 Subsequent international meetings have taken place at least biennially, with conferences at the
11 University of Toronto in 1997, Stanford University in 1999, the University of Maastricht in the
12 Netherlands in 2001, the University of Colorado in 2002, the University of Bergen in Norway in
13 2003, and the National Central University in Taiwan in 2005.

14 A specialized literature documenting theory and research in CSCL has developed since the
15 NATO-sponsored workshop in Maratea. Four of the most influential monographs are: Newman,
16 Griffin, and Cole (1989) *The Construction Zone*, Bruffee (1993) *Collaborative Learning*, Crook
17 (1994) *Computers and the Collaborative Experience of Learning*, and Bereiter (2002) *Education
18 and Mind in the Knowledge Age*.

19 Additionally, there have been a number of edited collections specifically focusing on CSCL
20 research: O’Malley (1995) *Computer-Supported Collaborative Learning*, Koschmann (1996b)
21 *CSCL: Theory and Practice of an Emerging Paradigm*, Dillenbourg (1999b) *Collaborative
22 Learning: Cognitive and Computational Approaches*, and Koschmann, Hall & Miyake (2002)
23 *CSCL2: Carrying Forward the Conversation*.

24 A book series on CSCL published by Kluwer (now Springer) includes five volumes to date
25 (Andriessen, Baker, & Suthers, 2003; Bromme, Hesse, & Spada, 2005; Goodyear *et al.*, 2004;
26 Strijbos, Kirschner, & Martens, 2004; Wasson, Ludvigsen, & Hoppe, 2003). The CSCL
27 conference proceedings have been the primary vehicle for publications in the field. A number of
28 journals have also played a role, particularly the *Journal of the Learning Sciences*. An
29 *International Journal of Computer-Supported Collaborative Learning* will start publishing in
30 2006. Although the community was centered in Western Europe and Northern America in its
31 early years, it has evolved into a rather well-balanced international presence (Hoadley, 2005;
32 Kienle & Wessner, 2005). The 2005 conference in Taiwan and the establishment of the new
33 international journal were planned to make the community truly global.

34 **From artificial intelligence to collaboration support**

35 The field of CSCL can be contrasted with earlier approaches to using computers in education.
36 Koschmann (1996a) identified the following historical sequence of approaches: (a) computer-
37 assisted instruction, (b) intelligent tutoring systems, (c) Logo as Latin, (d) CSCL. (a) Computer-
38 assisted instruction was a behaviorist approach that dominated the early years of educational
39 computer applications beginning in the 1960s. It conceived of learning as the memorization of
40 facts. Domains of knowledge were broken down into elemental facts that were presented to
41 students in a logical sequence through computerized drill and practice. Many commercial
42 educational software products still take this approach. (b) Intelligent tutoring systems were based

1 on a cognitivist philosophy that analyzed student learning in terms of mental models and
2 potentially faulty mental representations. They rejected the behaviorist view that learning could
3 be supported without concern for how students represented and processed knowledge.
4 Considered particularly promising in the 1970s, this approach created computer models of
5 student understanding and then responded to student actions based on occurrences of typical
6 errors identified in student mental models. (c) Efforts in the 1980s, epitomized by the teaching of
7 the Logo programming language, took a constructivist approach, arguing that students must build
8 their knowledge themselves. It provided stimulating environments for students to explore and to
9 discover the power of reasoning, as illustrated in software programming constructs: functions,
10 subroutines, loops, variables, recursion, etc. (d) During the mid-1990s, CSCL approaches began
11 to explore how computers could bring students together to learn collaboratively in small groups
12 and in learning communities. Motivated by social constructivist and dialogical theories, these
13 efforts sought to provide and support opportunities for students to learn together by directed
14 discourse that would construct shared knowledge.

15 At the time when mainframe computers were becoming available for school usage and micro-
16 computers started to appear, artificial intelligence (AI) was near the height of its popularity. So it
17 was natural that computer scientists interested in educational applications of computer
18 technology would be attracted by the exciting promises of AI. AI is computer software that
19 closely mimics behaviors that might be considered intelligent if done by a human (e.g., to play
20 chess by considering the pros and cons of alternative sequences of legal moves). Intelligent
21 tutoring systems are a prime example of AI, because they replicate the actions of a human
22 tutor— providing responses to student input (e.g., detailed steps in solving a math problem) by
23 analyzing the student problem-solving strategy and offering advice by comparing student actions
24 to programmed models of correct and erroneous understanding. This is still an active research
25 area within the learning sciences, but is limited to domains of knowledge where mental models
26 can be algorithmically defined.

27 In its most ambitious form, the AI approach sought to have the computer handle certain teaching
28 or guiding functions that would otherwise require a human teacher's time and intervention.
29 Within CSCL, the focus of learning is on learning through collaboration with other students
30 rather than directly from the teacher. Therefore, the role of the computer shifts from providing
31 instruction—either in the form of facts in computer-aided instruction or in the form of feedback
32 from intelligent tutoring systems—to supporting collaboration by providing media of
33 communication and scaffolding for productive student interaction.

34 The primary form of collaboration support is for the computer (i.e., the network of computers,
35 typically connected over the Internet) to provide a medium of communication. This may take the
36 form of email, chat, discussion forums, videoconferencing, instant messaging, etc. CSCL
37 systems typically provide a combination of several media and add special functionality to them.

38 In addition, CSCL software environments provide various forms of pedagogical support or
39 scaffolding for collaborative learning. These may be implemented with rather complex
40 computational mechanisms, including AI techniques. They can offer alternative views on the
41 ongoing student discussion and emerging shared information. They can provide feedback,
42 possibly based on a model of group inquiry. They can support sociability by monitoring
43 interaction patterns and providing feedback to the students. In most cases, the role of the
44 computer is secondary to the interpersonal collaboration process among the students (and, often,

1 the teacher, tutor or mentor). The software is designed to support, not replace, these human,
2 group processes.

3 The shift from mental models of individual cognition to support for collaborating groups had
4 enormous implications for both the focus and the method of research on learning. The gradual
5 acceptance and unfolding of these implications has defined the evolution of the field of CSCL.

6 **From individuals to interacting groups**

7 At about the time of the first biannual CSCL conference, Dillenbourg, et al. (1996) analyzed the
8 state of evolution of research on collaborative learning as follows.

9 For many years, theories of collaborative learning tended to focus on how *individuals*
10 function in a group. This reflected a position that was dominant both in cognitive
11 psychology and in artificial intelligence in the 1970s and early 1980s, where cognition was
12 seen as a product of individual information processors, and where the context of social
13 interaction was seen more as a background for individual activity than as a focus of
14 research. More recently, *the group itself has become the unit of analysis* and the focus has
15 shifted to more emergent, socially constructed, *properties of the interaction*.

16 In terms of empirical research, the initial goal was to establish whether and under what
17 circumstances collaborative learning was more effective than learning alone. Researchers
18 controlled several independent variables (size of the group, composition of the group,
19 nature of the task, communication media, and so on). However, these variables interacted
20 with one another in a way that made it almost impossible to establish causal links between
21 the conditions and the effects of collaboration. Hence, empirical studies have more recently
22 started to focus less on *establishing parameters for effective collaboration* and more on
23 trying to *understand the role that such variables play in mediating interaction*. This shift to
24 a more process-oriented account requires *new tools for analyzing and modeling*
25 *interactions*. (p. 189, emphasis added)

26 The research reviewed by Dillenbourg et al.—which studied the effects of manipulating
27 collaboration variables on the measures of individual learning—did not produce clear results.
28 Effects of gender or group composition (i.e., heterogeneous or homogeneous competence levels)
29 might be completely different at different ages, in different domains, with different teachers, and
30 so on. This not only violated methodological assumptions of variable independence, but raised
31 questions about how to understand what was behind the effects. To get behind the effects meant
32 to understand in some detail what was going on in the group interactions that might cause the
33 effects. This, in turn, required the development of methodologies for analyzing and interpreting
34 group interactions as such. The focus was no longer on what might be taking place “in the heads”
35 of individual learners, but what was taking place between and among them in their interactions.

36 **From mental representations to interactional meaning making**

37 The shift to the group unit of analysis coincided with a focus on the community as the agent of
38 situated learning (Lave, 1991) or collaborative knowledge building (Scardamalia & Bereiter,
39 1991). But it also called for the elaboration of a social theory of mind, such as Vygotsky
40 (1930/1978) had begun to outline, which could clarify the relation of individual learners to
41 collaborative learning in groups or communities.

1 According to Vygotsky, individual learners have different developmental capabilities in
2 collaborative situations than when they are working alone. His concept of the “zone of proximal
3 development” is defined as a measure of the difference between these two capabilities. This
4 means that one cannot measure the learning—even the individual learning—that takes place in
5 collaborative situations with the use of pre- and post-tests that measure capabilities of the
6 individuals when they are working alone. To get at what takes place during collaborative
7 learning, it does not help to theorize about mental models in the heads of individuals, because
8 that does not capture the shared meaning making that is going on during collaborative
9 interactions.

10 Collaboration is primarily conceptualized as a process of shared meaning construction. The
11 meaning making is not assumed to be an expression of mental representations of the individual
12 participants, but is an interactional achievement. Meaning making can be analyzed as taking
13 place across sequences of utterances or messages from multiple participants. The meaning is not
14 attributable to individual utterances of individual students because the meaning typically depends
15 upon indexical references to the shared situation, elliptical references to previous utterances and
16 projective preferences for future utterances (Stahl, 2006).

17 **From quantitative comparisons to micro case studies**

18 To observe learning in collaborative situations is different from observing it for isolated learners.
19 First, in situations of collaboration, participants necessarily visibly display their learning as part
20 of the process of collaboration. Second, the observations take place across relatively short
21 periods of group interaction, rather than across long periods between pre- and post-tests.

22 Ironically, perhaps, it is in principle easier to study learning in groups than in individuals. That is
23 because a necessary feature of collaboration is that the participants display for each other their
24 understanding of the meaning that is being constructed in the interaction. Utterances, texts and
25 diagrams that are produced during collaboration are designed by the participants to display their
26 understanding. That is the basis for successful collaboration. Researchers can take advantage of
27 these displays (assuming that they share the participants’ interpretive competencies and can
28 capture an adequate record of the displays, e.g., on digital video). Researchers can then
29 reconstruct the collaborative process through which group participants constructed shared
30 meaning, which was learned as a group.

31 Methodologies like conversation analysis (Sacks, 1992; ten Have, 1999) or video analysis
32 (Koschmann, Stahl, & Zemel, 2005) based on ethnomethodology (Garfinkel, 1967) produce
33 detailed case studies of collaborative meaning making. These case studies are not merely
34 anecdotal. They can be based on rigorous scientific procedures with intersubjective validity even
35 though they are interpretive in nature and are not quantitative. They can also represent generally
36 applicable results, in that the methods that people use to interact are widely shared (at least
37 within appropriately defined communities or cultures).

38 How can the analysis of interactional methods help to guide the design of CSCL technologies
39 and pedagogies? This question points to the complex interplay between education and computers
40 in CSCL.

The interplay of learning and technology in CSCL

The traditional conception of learning

Edwin Thorndike (1912), a founder of the traditional educational approach, once wrote:

If, by a miracle of mechanical ingenuity, a book could be so arranged that only to him who had done what was directed on page one would two become visible, and so on, much that now requires personal instruction could be managed by print Children [could] be taught, moreover to use materials in a manner that will be most useful in the long run. (p. 165)

This quotation is notable in two respects. For one, it suggests that the central idea of computer-aided instruction long preceded the actual development of computers; but, more importantly, it also shows how the goal of research in educational technology is closely tied, indeed indistinguishable from, the conventional goal of educational research, namely to enhance learning as it is operationally defined. Thorndike envisioned an educational science in which all learning is measurable and, on this basis, by which all educational innovations could be experimentally evaluated. Historically, research on educational technology has been tied to this tradition and represents a specialization within it (cf., Cuban, 1986).

In the past, educational researchers have treated learning as a purely psychological phenomenon. Learning is seen to have three essential features: First, it represents a response to and recording of experience. Second, learning is always treated as a change that occurs over time. Finally, learning is generally seen as a process not available to direct inspection (Koschmann, 2002a). This formulation is so culturally entrenched that it is difficult to conceive of learning in any other way. It rests upon established traditions in epistemology and philosophy of mind.

Contemporary philosophy has called these traditions into question, however. The so-called “edifying philosophers” (Rorty, 1974)—James, Dewey, Wittgenstein and Heidegger—rebelled against the view of learning as an inaccessible event in which knowledge is inscribed in an individual mind. They aspired to construct a new view of learning and knowing, one that properly located it in the world of everyday affairs. CSCL embraces this more situated view of learning, thereby rejecting the foundations of conventional educational research. CSCL locates learning in meaning negotiation carried out in the social world rather than in individuals’ heads. Of the various socially oriented theories of learning, social practice theory (Lave & Wenger, 1991) and dialogical theories of learning (e.g., Hicks, 1996) speak most directly to a view of learning as socially organized meaning construction. Social practice theory focuses on one aspect of meaning negotiation: the negotiation of social identity within a community. Dialogical theories locate learning in the emergent development of meaning within social interaction. Taken together, they comprise a basis for a new way of thinking about and studying learning.

Designing technology to support group meaning making

The goal for design in CSCL is to create artifacts, activities and environments that enhance the practices of group meaning making. Rapid advances in computer and communication technologies in recent decades, like the Internet, have dramatically changed the ways in which we work, play, and learn. No form of technology, however, no matter how cleverly designed or sophisticated, has the capacity, in and of itself, to change practice. To create the possibility of an enhanced form of practice requires more multifaceted forms of design (bringing in expertise,

1 theories and practices from various disciplines): design that addresses curriculum (pedagogical
2 and didactic design), resources (information sciences, communication sciences), participation
3 structures (interaction design), tools (design studies), and surrounding space (architecture).

4 As the title of a commentary by LeBaron (2002) suggests, “Technology does not exist
5 independent of its use.” Substitute ‘activities, artifacts, and environments’ for ‘technology’ and
6 the message remains the same—these elements themselves cannot define new forms of practice,
7 but are instead constituted within practice. An environment for a desired form of practice
8 becomes such through the organized actions of its inhabitants. Tools and artifacts are only tools
9 and artifacts in the ways in which they are oriented to and made relevant by participants in
10 directed practice. Even activities are only rendered recognizable as such in the ways that
11 participants orient to them as ordered forms of joint action.

12 Design of software for CSCL, therefore, must be coupled with analysis of the meanings
13 constructed within emergent practice. Meanings reflect past experience and are open to endless
14 negotiation and re-evaluation. Furthermore, neither analysts nor participants have privileged
15 access to others’ subjective interpretations. Despite these issues, participants routinely engage in
16 coordinated activity and operate as if shared understanding was both possible and being
17 achieved. A fundamental question, therefore, is how is this done? In order to design technology
18 to support collaborative learning and knowledge building, we must understand in more detail
19 how small groups of learners construct shared meaning using various artifacts and media.

20 The question of how *intersubjectivity* is accomplished has been taken up in a variety of
21 specialized disciplines such as pragmatics (Levinson, 2000; Sperber & Wilson, 1982), social
22 psychology (Rommetveit, 1974), linguistic anthropology (Hanks, 1996), and sociology (cf.
23 Goffman, 1974), especially sociological research in the ethnomethodological tradition
24 (Garfinkel, 1967; Heritage, 1984). The problem of intersubjectivity is of particular relevance for
25 those who wish to understand how learning is produced within interaction. Learning can be
26 construed as the act of bringing divergent meanings into contact (Hicks, 1996), and instruction as
27 the social and material arrangements that foster such negotiation. The analysis of meaning-
28 making praxis calls for the appropriation of the methods and concerns of psychology (especially
29 the discursive and cultural varieties), sociology (especially the micro-sociological and
30 ethnomethodologically informed traditions), anthropology (including linguistic anthropology and
31 anthropologies of the built environment), pragmatics, philosophy, communication studies,
32 organizational science, and others.

33 CSCL research has both analytic and design components. Analysis of meaning making is
34 inductive and indifferent to reform goals. It seeks only to discover what people are doing in
35 moment-to-moment interaction, without prescription or assessment. Design, on the other hand, is
36 inherently prescriptive—any effort toward reform begins from the presumption that there are
37 better and worse ways of doing things. To design for improved meaning making, however,
38 requires some means of rigorously studying praxis. In this way, the relationship between analysis
39 and design is a symbiotic one—design must be informed by analysis, but analysis also depends
40 on design in its orientation to the analytic object (Koschmann *et al.*, 2005).

41 CSCL must continue with its work of self-invention. New sources of theory must be introduced,
42 analyses of learner practice presented, and artifacts produced accompanied by theories of how
43 they might enhance meaning-making. The design of CSCL technology, which opens new

1 possibilities for collaborative learning, must be founded on an analysis of the nature of
2 collaborative learning.

3 **The analysis of collaborative learning**

4 Koschmann (2002b) presented a programmatic description of CSCL in his keynote at CSCL
5 2002:

6 CSCL is a field of study centrally concerned with meaning and the practices of meaning-
7 making in the context of joint activity, and the ways in which these practices are mediated
8 through designed artifacts. (p. 18)

9 The aspect of collaborative learning that is perhaps hardest to understand in detail is what may be
10 called “practices of meaning-making in the context of joint activity,” *intersubjective learning*
11 (Suthers, 2005) or *group cognition* (Stahl, 2006). This is learning that is not merely
12 accomplished interactionally, but is actually *constituted* of the interactions between participants.
13 Following Garfinkel, Koschmann et al. (2005) argue for the study of “member’s methods” of
14 meaning making: “how participants in such [instructional] settings actually go about *doing*
15 learning” (emphasis in original). In addition to understanding how the cognitive processes of
16 participants are influenced by social interaction, we need to understand how learning events
17 themselves take place in the interactions between participants.

18 The study of joint meaning making is not yet prominent within CSCL practice. Even where
19 interaction processes (rather than individual learning outcomes) are examined in detail, the
20 analysis is typically undertaken by assigning coding categories and counting pre-defined
21 features. The codes, in effect, substitute preconceived categories of behavior for the phenomenon
22 of interest rather than seeking to discover those phenomena in their unique situations (Stahl,
23 2002).

24 A few studies published in the CSCL literature have directly addressed this problem of
25 describing the constituting of intersubjectivity in interaction (for example, Koschmann *et al.*,
26 2003; Koschmann *et al.*, 2005; Roschelle, 1996; Stahl, 2006). Roschelle’s early study designed
27 software especially to support meaning making related to physics, defined student activities to
28 engage learners in joint problem solving, and analyzed their collaborative practices in micro
29 detail. Koschmann’s work has generally focused on participants’ methods of *problematization*:
30 how groups of students collectively characterize a situation as problematic and as requiring
31 further specific analysis.

32 Stahl (2006) argues that small groups are the most fruitful unit for the study of intersubjective
33 meaning making, for several reasons. Most simply, small groups are where members’ methods
34 for intersubjective learning can be observed. Groups of several members allow the full range of
35 social interactions to play out, but are not so large that participants and researchers alike
36 necessarily lose track of what is going on. The shared construction of meaning is most visible
37 and available for research at the small-group unit of analysis, where it appears as *group*
38 *cognition*. Moreover, small groups lie at the boundary of, and mediate between, individuals and a
39 community. The knowledge building that takes place within small groups becomes “internalized
40 by their members as individual learning and externalized in their communities as certifiable
41 knowledge” (Stahl, 2006). However, small groups should not be the only social granularity
42 studied. Analysis of large-scale changes in communities and organizations may lead to an

1 understanding of emergent social-learning phenomena as well as elucidate the role of embedded
2 groups in driving these changes.

3 The study of the interactional accomplishment of intersubjective learning or group cognition
4 gives rise to interesting questions that are among the most challenging facing any social-
5 behavioral science, and even touch upon our nature as conscious beings. Do cognitive
6 phenomena take place trans-personally in group discourse? How is it possible for learning,
7 usually conceived of as a cognitive function, to be distributed across people and artifacts? How
8 can we understand knowledge as accomplished practice rather than as a possession or even
9 predisposition?

10 **The analysis of computer support**

11 In CSCL contexts, the group interactions among individuals are mediated by computer
12 environments. The second half of Koschmann's programmatic definition of the domain of CSCL
13 is "the ways in which these practices [meaning-making in the context of joint activity] are
14 mediated through designed artifacts." Computer support for intersubjective meaning making is
15 what makes the field unique.

16 The technology side of the CSCL agenda focuses on the design and study of fundamentally
17 social technologies. To be fundamentally social means that the technology is designed
18 specifically to mediate and encourage social acts that constitute group learning and lead to
19 individual learning. Design should leverage the unique opportunities provided by the technology
20 rather than replicate support for learning that could be done through other means, or (worse) try
21 to force the technology to be something for which it is not well suited. What is unique to
22 information technology that can potentially fill this role?

- 23 • Computational media are reconfigurable. Representations are dynamic: it is easy to move
24 things around and undo actions. It is easy to replicate those actions elsewhere: one can bridge
25 time and space. These features make information technology attractive as a "communication
26 channel," but we should exploit technology for its potential to make new interactions
27 possible, not try to force it to replicate face-to-face interaction.
- 28 • Computer-mediated communication environments "turn communication into substance"
29 (Dillenbourg, 2005). A record of activity as well as product can be kept, replayed, and even
30 modified. We should explore the potential of the persistent record of interaction and
31 collaboration as a resource for intersubjective learning.
- 32 • Computational media can analyze workspace state and interaction sequences, and
33 reconfigure itself or generate prompts according to features of either. We should explore the
34 potential of adaptive media as an influence on the course of intersubjective processes, and
35 take advantage of its ability to prompt, analyze and selectively respond.

36 Human communication and the use of representational resources for this communication is
37 highly flexible: technologies can open possibilities, but they cannot "fix" meanings or even
38 specify communicative functions (Dwyer & Suthers, 2005). Informed by this fact, CSCL
39 research should identify the unique advantages of computational media, and explore how these
40 are used by collaborators and how they influence the course of their meaning making. Then we
41 will design technologies that offer collections of features through which participants can
42 interactionally engage in learning with flexible forms of guidance.

The multi-disciplinarity of CSCL

1
2 CSCL can presently be characterized as consisting of three methodological traditions:
3 experimental, descriptive and iterative design.

4 Many empirical CSCL studies follow the dominant *experimental* paradigm that compares an
5 intervention to a control condition in terms of one or more variables (e.g., Baker & Lund, 1997;
6 Rummel & Spada, 2005; Suthers & Hundhausen, 2003; Van Der Pol, Admiraal, & Simons,
7 2003; Weinberger *et al.*, 2005). Data analysis in most of these studies is undertaken by “coding
8 and counting”: interactions are categorized and/or learning outcomes measured, and group means
9 are compared through statistical methods in order to draw general conclusions about the effects
10 of the manipulated variables on aggregate (average) group behavior. These studies do not
11 directly analyze the accomplishment of intersubjective learning. Such an analysis must examine
12 the structure and intention of unique cases of interaction rather than count and aggregate
13 behavioral categories.

14 The ethnomethodological tradition (exemplified in CSCL by Koschmann *et al.*, 2003;
15 Koschmann *et al.*, 2005; Roschelle, 1996; Stahl, 2006) is more suited for *descriptive* case
16 analyses. Video or transcripts of learners or other members of the learning community are
17 studied to uncover the methods by which groups of participants accomplish learning. The
18 grounded approach is data-driven, seeking to discover patterns in the data rather than imposing
19 theoretical categories. The analysis is often micro-analytic, examining brief episodes in great
20 detail. Descriptive methodologies are well suited to existentially quantified claims (e.g., that a
21 community sometimes engages in a given practice). Yet, as scientists and designers we would
22 like to make causal generalizations about the effects of design choices. Descriptive
23 methodologies are less suited for providing quantitative proof that an intervention has an effect,
24 which is the province of experimental methodology, although it can often understand how very
25 general practices work.

26 The traditional analytic methods of experimental psychology miss the “member methods”
27 through which collaborative learning is accomplished—intersubjective meaning making. But this
28 does not imply that all CSCL research should be ethnomethodological. Rather, the foregoing
29 considerations suggest that we explore hybrid research methodologies (Johnson & Onwuegbuzie,
30 2004). Experimental designs can continue to compare interventions, but the comparisons would
31 be made in terms of the features identified in micro-analyses of how information technology
32 influences and is appropriated for members’ methods of joint meaning making. Conceptually, the
33 process analysis changes from “coding and counting” to “exploring and understanding” ways in
34 which design variables influence support for meaning-making. Such analyses are time intensive:
35 we should explore, as research aids, the development of instrumentation for learning
36 environments and automated visualization and querying of interaction logs (as in Cakir *et al.*,
37 2005; Donmez *et al.*, 2005). Conversely, traditional analyses, especially measures of learning
38 outcomes but also “coding and counting,” might also be retained to obtain quick indicators of
39 where more detailed analyses are merited, thereby focusing the detail work (as in Zemel, Xhafa,
40 & Stahl, 2005).

41 The *iterative design* tradition is exemplified by Fischer & Ostwald (2005), Lingnau, et al. (2003)
42 and Guzdial et al. (1997). Driven by the interactions among evolving theory, informal
43 observations and stakeholder engagement, design-oriented researchers continuously improve the
44 artifacts intended to mediate learning and collaboration. Their research is not necessarily either

1 qualitative or quantitative, but may also be “quisitive” (Goldman, Crosby, & Shea, 2004)—
2 explorative and interventionist. It is not enough to just observe people’s behaviors when they use
3 new software. We need to explore the “space” of possible designs, pushing into new areas and
4 identifying promising features that should receive further study under the other methodological
5 traditions. Designers need to conduct microanalyses of collaborative learning with and through
6 technology in order to identify the features of designed artifacts that seem to be correlated with
7 effective learning. When a new technical intervention is tested, experimental methods can be
8 used to document significant differences while descriptive methods can document how the
9 interventions mediated collaborative interactions differently. A conversation between the
10 theoretical assumptions of ethnomethodology and those of design can lead to a
11 “technomethodology” that changes the very objectives of design (Button & Dourish, 1996).

12 A potential limitation of descriptive methodologies should be noted. If we focus on finding
13 examples of how members accomplish effective learning, we may miss abundant examples of
14 how they also fail to do so. Yet in order to find that something is not there, we need to have an
15 idea of what we are looking for. A purely data-driven approach that derives theory, but never
16 applies it, won’t be adequate. Descriptive methods can be modified to address this need.
17 Common patterns found in successful learning episodes subsequently become the theoretical
18 categories we look for elsewhere with analytic methods, and perhaps do not find in instances of
19 unsuccessful collaboration. Having identified where the successful methods were *not* applied, we
20 then examine the situation to determine what contingency was missing or responsible. Unique
21 and un-reproducible instances where collaboration using technology breaks down in interesting
22 ways can often provide the deepest insights into what is happening, but what is normally taken
23 for granted and invisible. Care should be taken, however, to make sure that in finding case
24 examples where the interactional accomplishment of learning is absent we do not fail to notice
25 where something else of value to the participants *is* being accomplished! For example,
26 establishment and maintenance of individual and group identity are worthwhile accomplishments
27 as far as the participants are concerned (Whitworth, Gallupe, & McQueen, 2000), and indeed are
28 a form of situated learning, even though researchers may initially identify it as “off topic” social
29 chatting.

30

CSCL research in the future

31 We have seen that research in CSCL must respond to multiple goals and constraints. The
32 research community necessarily includes people from a variety of professional and disciplinary
33 backgrounds and trainings. They bring with them different research paradigms, contrasting views
34 of data, analysis methods, presentation formats, concepts of rigor and technical vocabularies.
35 They come from around the world with various cultures and native languages. CSCL is a rapidly
36 evolving field, located at the intersection of other fields (like the learning sciences generally) that
37 are themselves undergoing continuous change. Community participants at any given time are
38 operating within diverse conceptions of what CSCL is all about. For instance, Sfard (1998)
39 defines two broad and irreconcilable metaphors of learning that are necessarily relevant to
40 CSCL: the acquisition metaphor, in which learning consists of individuals acquiring knowledge
41 stored in their minds, and the participation metaphor, in which learning consists of increasing
42 participation in communities of practice. Lipponen, Hakkarainen & Paavola, (2004) adds a third
43 metaphor based on Bereiter (2002) and Engeström (1987): the knowledge creation metaphor, in
44 which new knowledge objects or social practices are created in the world through collaboration.
45 Consequently, it is hard to present a well-defined, consistent and comprehensive definition of

1 CSCL theory, methodology, findings or best practices. Perhaps one must conclude that CSCL
2 today necessarily pursues seemingly irreconcilable approaches—as Sfard argues. One can
3 speculate that more integrated, hybrid approaches may be possible in the future, as we have tried
4 to suggest.

5 Research methodology in CSCL is largely trichotomized between experimental, descriptive and
6 iterative design approaches. Although sometimes combined within a single research project, the
7 methodologies are even then typically kept separate in companion studies or separate analyses of
8 a single study. Different researchers sometimes wear different hats on the same project,
9 representing different research interests and methodologies. This situation may still be
10 productive: the experimentalists continue to identify variables that effect general parameters of
11 collaborative behavior, the ethnomethodologists identify patterns of joint activity that are
12 essential to the meaning-making, and designers innovate to creatively adapt new technological
13 possibilities. Soon, however, experimentalists within CSCL may start to focus on the dependent
14 variables that directly reflect the phenomenon of interest to the descriptive researchers (Fischer
15 & Granoo, 1995), ethnomethodologists may look for *predictive* regularities in technology-
16 mediated meaning making that can inform design, and the designers may generate and assess
17 promising new technology affordances in terms of the meaning-making activities they enable.
18 Mutual assistance and closer collaboration may be possible through hybrid methodologies, for
19 example by applying richer descriptive analytic methods to the problem of understanding the
20 implications of experimental manipulations and new designs, or through computer support for
21 our own meaning-making activities as researchers.

22 CSCL researchers form a community of inquiry that is actively constructing new ways to
23 collaborate in the design, analysis and implementation of computer support for collaborative
24 learning. A broad range of research methods from the learning sciences may be useful in
25 analyzing computer-supported collaborative learning. Having appropriated ideas, methods and
26 functionality from cognate fields, CSCL may in its next phase collaboratively construct new
27 theories, methodologies and technologies specific to the task of analyzing the social practices of
28 intersubjective meaning making in order to support collaborative learning. The authors of this
29 essay have argued that CSCL requires a focus on the meaning-making practices of collaborating
30 groups and on the design of technological artifacts to mediate interaction, rather than a focus on
31 individual learning. Whether this focus can, will or should lead to a coherent theoretical
32 framework and research methodology for CSCL remains to be seen.

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