Toward a Theory of Computer Support for Collaborative Learning

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Things change. For decades teachers have adhered to the familiar and the routine, teaching largely as they themselves were taught (Cuban, 1993). But there are signs of change in today’s classroom. Teachers are beginning to seek new theories and approaches to learning. One currently prominent theme of change is the movement away from the traditional, teacher-centered approach to instruction toward more collaborative approaches such as cooperative learning (Slavin et al., 1985), project-based learning (Blumenfeld et al., 1991), problem-based learning (Barrows & Tamblyn, 1980), and reciprocal instruction (Palincsar & Brown, 1984) in which peer-to-peer interaction is highly valued.

One interesting question, with respect to these newly emerging forms of instruction, is how can they be supported and enhanced by technology? The dominant paradigm for past work in the use of computers (both in instruction and in other settings) has involved designing software for the solitary user. Recently, however, researchers have begun to investigate the practices and shared artifacts by which groups coordinate their work with an eye toward the development of new facilitating technologies (Bødker & Pederson, 1991). This emerging area of study, known as computer support for cooperative work (CSCW), is founded on the notion that computers can be used to facilitate, augment, and even redefine interactions among members of a work group (Galegher & Kraut, 1990). The term *groupware* has been coined for software that is meant to be used by groups rather than single individuals (Stefik & Brown, 1989). Research in this area has stimulated interest in the educational possibilities engendered by CSCW, and the acronym CSCL is often used for computer support of collaborative learning, the more focused study of the use of collaboration technology in instruction.

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WHAT IS IN AN ACRONYM? (OR WHAT IS THE SECOND "C" IN CSCL?)

There has been some controversy surrounding what the letters CSCL represent. When we organized our first workshop on CSCL in 1991 (Koschmann, 1992), we billed it as the Workshop on Computer Support for Cooperative Learning—simply substituting learning for work and drawing on the perceived connection to prior research in CSCW. Trent Batson sent me a note at the time observing that cooperative learning has a special meaning in the education world (cf., Slavin et al., 1985) and encouraging me to consider collaborative learning as an alternative. Although the term collaborative learning was also not new (e.g., Greeno, 1986), it had yet to denote any specific set of educational methods. We, therefore, decided to change the name of our workshop to the Workshop on Computer Support for Collaborative Learning.¹ In this issue, Roy Pea argues that collaborative learning is often not descriptive of what we find happening in the classroom and suggests that collective learning may be a more apt term. I think the term coordinated learning may also apply (in the sense in which the term coordinated activity is used by social constructivists (Blumer, 1969; Heritage, 1984; Suchman, 1987) to describe the mutually constitutive interactions of individuals in social settings. At this point, however, the best policy might be to simply use the acronym, allowing individual interpretation of what the letters might actually represent.

CSCL applications can be categorized by a number of dimensions (O'Malley & Koschmann, 1993). Three important ones are the locus of use, how the use is coordinated in time, and the intended instructional role of the application. CSCL applications have been designed to be used in a variety of settings—applications for use in the classroom (intra-classroom applications), applications that connect users across classrooms (inter-classroom applications), and applications that are used outside the classroom (extra-classroom applications). Many CSCL applications involve groups of learners working on different (but connected) processors. Depending on the application, their interaction can be coordinated synchronously or asynchronously.² The instructional role of the application may also be quite variable. Technology, for example, can be used to present or simulate a problem for study, helping to situate it in a real-world context (e.g., Jason Woodbury Math Series; Bransford & The Cognition and Technology Group at Vanderbilt, 1992). Alternatively, computers can be used to mediate communication

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¹A workshop with the same name had been organized a year earlier in Maratea, Italy, under the auspices of the NATO Special Programme on Advanced Educational Technology (O'Malley, in press). Tim O'Shea (personal communication) informed me that the term computer-supported collaborative learning was already in use in Europe as early as 2 years prior to that meeting.

²A telephone call is a paradigmatic example of a synchronized interaction; correspondence through the mail is an example of asynchronous communication.
within (Bruce & Peyton, 1991) and across classrooms (e.g., Learning Circles on the AT&T Learning Network; Riel, 1992) and to introduce new resources into the classroom (Pea, 1993). Computers can provide archival storage for the products of group work, thereby supporting "knowledge building" (Scardamalia & Bereiter, 1991) and "communities of learning" (Campione, Brown, & Jay, 1992). Finally, computers can support the creation of representational formalisms that enable learners to model their shared understanding of new concepts (e.g., the Envisioning Machine; Roschelle, 1992).

OVERVIEW OF THIS SPECIAL ISSUE

The articles that appear in this issue were first presented in 1992 at an American Educational Research Association Symposium entitled "Theories Underlying the Use of Networked Computers in the Classroom." This special issue was put together to allow the presenters to further refine their ideas and present them in a more coherent form.

The first article describes work being undertaken at the Southern Illinois University School of Medicine. We begin by enumerating our own commitments with respect to teaching and learning in the form of a list of principles. We then describe how these principles are served by a particular approach to collaborative instruction, known as problem-based learning (PBL). Finally, we discuss several ways that technology could be used to support and enhance PBL. The applications described are largely designed for intraclassroom use, though support for extra-classroom activities is also planned. They include using computers to present clinical problems for study, to mediate communication in face-to-face meetings, and to provide archival storage of the group's deliberations.

The article by Scardamalia and Bereiter describes the theories of learning and instruction underlying the Computer-Supported Intentional Learning Environments (CSILE) project (Scardamalia et al., 1992) at the Ontario Institute for Studies in Education. The CSILE provides a framework in the form of a hypertext journal for creating, editing, storing, annotating, and retrieving materials generated by a team of students working on a common project. An important feature of the CSILE project is that material gathered by one team of students can be used as a resource for future groups. Scardamalia and Bereiter view this kind of "knowledge-building" activity as similar in many ways to the activities that occur in academic research communities. As described, the CSILE program is an example of another intra-classroom application, although the emphasis on knowledge building imparts an inter-classroom flavor (i.e., for classrooms separated by time rather than space).

A fourth paper (by Denis Newman) was also presented at that symposium but was, regrettably, not available for inclusion in this issue.
In the third article, Roy Pea argues for a transformative view of communication by which both teachers and students are transformed through the process of communication. He asserts that educators have traditionally embraced a transmissive view of communication and as a consequence have failed to recognize the social and material embeddedness of interaction in the classroom. Pea then describes the Dynagrams project as an example of a research project inspired by a transformative perspective. This project was undertaken to investigate ways in which technology could be used to augment student sense-making in the context of solving optics problems in a high-school physics course. The Dynagrams project is another example of an intra-classroom CSCL application, in this case one in which a specially designed microworld provided a representational formalism to support a desired form of conversation among student problem solvers. Pea's more recent work has moved in the direction of inter-classroom and extra-classroom applications. The Collaborative Visualization (CoVis) project (Pea, 1993) focuses on the use of high-speed telecommunications gear to provide similar kinds of representational support for dispersed groups of students.

WHY COLLABORATIVE INSTRUCTION?

On the surface, the applications described in this issue may appear to have little in common—some are used in the classroom, but some are not; some involve networks, but some reside on a single machine; some are used in real time, but some are used asynchronously. What they do hold in common, however, is a concern for the importance of supporting collaboration in instruction.

Each of the articles presents a slightly different argument for why we need collaborative instruction in the first place. The article by Koschmann, Myers, Feltovich, and Barrows, for example, presents collaborative learning as one way of addressing some of the known failures of traditional methods of instruction (e.g., low rates of retention, failure to transfer learning, inability of learners to apply knowledge flexibly). Learning in groups provides opportunities for exposure to multiple perspectives and interpretations. It also provides participants with opportunities to articulate their newly acquired knowledge. For Scardamalia and Bereiter, the idea of knowledge building in CSILE is to allow learners to make the fruits of their research apparent to and usable by their peers. This, they hope, will enhance the intentional character of their learning. The argument is largely a motivational one. Pea's article argues for a new model of communication in the classroom, one that acknowledges its transformative character. If classroom discussions are viewed as transformative activities, they can be understood in a different way, leading, we hope, to the development of new and better forms of instruction. He privileges a particular type of conversation—the
sense-making conversation that leads to the social construction of understanding and individual conceptual change. What characterizes collaborative learning is a model of instruction that honors other types of communication (i.e., peer-to-peer, student-to-teacher) in addition to the traditional one-way communication of teacher to student. A theory of communication is central, therefore, to a theory of collaborative learning.

SOME OTHER EMERGENT THEMES

Two other important themes present themselves in these articles—a view of the learner as an active participant in the learning process and the need for new forms of communication in the classroom.

All three articles maintain a view of learning as an active process. This is taken up in the article by Koschmann et al. as one of the six principles of effective learning and instruction (i.e., the Principle of Activeness). The notion of intentional learning developed by Scardamalia and Bereiter in this issue and elsewhere (Scardamalia & Bereiter, 1989, 1991) implicitly assumes a model in which learning is a constructive process. They suggest in their article that one of the central problems of education today is that schools are too much like factories in which the workers have little or no input into the design of the product. Finally, Pea writes “Students are not blank slates, written upon with curricular lessons. They are active [italics added] learners ...” (p. 290).

As mentioned earlier, what distinguishes collaborative forms of instruction from more conventional methods of teaching is a shift in the types of communication that are sanctioned. It is not surprising, therefore, that all three articles directly address issues of classroom discourse and call for new forms of conversational activities to support instruction. This is the central message of Pea’s article, but it emerges as an important theme in the other two articles as well. For example, Scardamalia and Bereiter state, “Knowledge-building discourse is at the heart of the superior education that we have in mind” (p. 266). These new patterns of discourse may introduce new instructional challenges, however. Koschmann et al.’s and Scardamalia and Bereiter’s articles both observe that because of the nature of group dynamics, simple discussion may not be the most efficacious way of achieving group sense making. Both articles express hope, however, that these limitations of group discussion can be addressed through the introduction of new technologies.

This special issue was conceived to serve at least two objectives: first, to provide a representative sample of ongoing work in CSCL; second, to elucidate some of the underlying theories that currently inform design in the area. I believe that it succeeds on both counts. My greatest hope is that it will initiate a wider discussion of the important issues pertaining to the introduction of technologies into collaborative learning settings.
REFERENCES


