Collaborative Learning and Computer-Supported Groups

David P. Brandon and Andrea B. Hollingshead

Computer-supported collaborative learning (CSCL) is the educational use of on-line groups. Utilizing on-line groups for instruction requires an understanding of the multiple issues involved in CSCL, such as the pedagogy applicable to groups and how communication technology influences group interaction. Theoretical and empirical research relevant to the use of CSCL–including collaborative learning research and computer-mediated communication research–is discussed using a descriptive model to categorize the extant literature. The model provides guidance in designing and utilizing CSCL activities with university-level groups.
Keywords: collaborative learning, computer-mediated communication, group communication, on-line groups

There is little doubt that Internet-based computer-mediated communication (CMC) technologies are shaping the future of higher education. Communication technologies that are free from time/place constraints and support many-to-many communication, such as text-based computer conferencing, provide new options on how education can be designed and delivered to students (Harasim, 1989, 1991). Technologies that support group communication offer more than just tools to supplement traditional classroom learning; whole new educational environments can be developed on-line that can benefit both pedagogy and student career preparation (Kiesler, 1992; Witmer, 1998). Educational benefits that researchers have associated with the use of technologies that support on-line groups include: increased student responsibility, initiative, and participation (McComb, 1994); greater communication with peers and discussion of course concepts (King, 1994); greater learning and higher grades (Althaus, 1997); and, preparation for work groups such as virtual teams (Everett & Ahern, 1994; Lipnack & Stamps, 1997).

However, instructors face a substantial challenge in developing educational activities for on-line groups, which involves reconciling technological, pedagogical, and student issues into an effective learning experience (Waggoner, 1992). As noted by Witmer (1998), instructors face multiple obstacles just getting students to use CMC technologies for learning purposes. Additionally, many instructors are ill-prepared to develop activities for on-line groups due to a lack of familiarity with learning in an on-line environment (Harasim, 1991), an eagerness to employ a CMC technology without due consideration of pedagogical issues (Anderson, 1996), or a lack of experience using learning groups in the standard classroom (Ahern, Peck, & Laycock, 1992).

One suggested means for designing and managing on-line group learning projects is to draw on collaborative learning concepts developed for standard classrooms as a means of structuring and coordinating electronic learning spaces (Harasim, 1991;

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Hooper, 1992). The emerging field of computer-supported collaborative learning (CSCL) seeks to combine classroom-based collaborative learning theory with theory and research on CMC in order to provide a foundation for understanding how CMC-based group projects can enhance learning. CSCL research is still working towards developing a body of theory that incorporates all of the applicable pedagogical and theoretical issues involved in a CSCL project (Blumenfeld, Marx, Soloway, & Krajcik, 1996).

To that end, this article brings together CSCL-related theory and research from a variety of fields with the goal of highlighting the issues and the decisions involved in the implementation of learning activities for on-line groups in communication courses. Theory and research from education, communication, management and information systems (MIS), and psychology is summarized and integrated into a model. The model shows that the effective use of on-line groups in the classroom is dependent on interrelations between the nature of the collaboration, communication, and features of the social context. This model can be used to derive a set of guidelines that can aid in the design CSCL activities in communication courses.

The scope of this review is based on several criteria. First, the discussion is limited to the instructional use of groups of three to four students, the group size common to standard classroom collaborative learning methods and recommended for on-line groups (Harasim, 1991; Sharan, 1994; Slavin, 1988). Second, college students taking a course for credit over a semester-long period are the focus, since higher education is the level most likely to benefit from CSCL programs (Mayes & Neilson, 1995). Third, the computer-conferencing tools employed are commonly available across colleges and universities and involve the use of asynchronous text-based computer conferencing tools or similar form of groupware (Jessup & Valacich, 1993). Lastly, it is assumed that group members have not worked together before and that the majority of group interaction occurs in the on-line environment, with little or no face-to-face contact.

Collaborative Learning in CSCL Research

Work on CSCL draws primarily from two contributing fields of inquiry, collaborative learning theory and CMC theory and research (Harasim, 1991; Koschmann, Myers, Feltovich, & Barrows, 1994). A substantial body of research indicates that collaborative learning can be effective in generating positive academic and affective outcomes in traditional classroom settings (Johnson, Johnson, & Smith, 1991; O'Donnell & O'Kelly, 1994; Slavin, 1991). These positive outcomes are not limited to the primary and secondary levels of education. A meta-analysis of university-level and adult-learning courses found that use of collaborative learning concepts promoted higher achievement, higher-level reasoning, more frequent generation of ideas and solutions, and greater transfer of learning than did individualistic or competitive learning strategies (Johnson et al., 1991).

However, collaborative learning theory has dealt primarily with standard, classroom-based groups, not electronic groups, which raises the question of how well the benefits of collaborative learning will translate to the electronic environment. Several researchers have argued that the fusion of collaborative learning and CMC technologies is mutually beneficial, since collaborative learning helps structure the on-line environment, and CMC technology removes many of the barriers to collaborative learning (Alavi, 1994; Harasim, 1991; Hooper, 1992; King, 1994).

CSCL is about how technology can be used to support collaborative learning (Koschmann, 1994).

A distinction made in collaborative learning research about whether group members are sharing the workload or working to develop shared meaning is also important to CSCL research. The term "collaboration" in collaborative learning research is often used to refer to either cooperation-based (group members share the workload) or collaboration-based (group members develop shared meanings about their work) learning activities (Webb & Palincsar, 1996). For example, in a cooperation-based learning activity, group members write four separate sections of a paper independently and perhaps work more closely together to write an introduction and conclusion. In a collaboration-based activity, group members produce a single, unified group paper that represents the shared reasoning and conclusions of the group as a unit. While cooperation and collaboration are interrelated, there is a clear difference in what the terms emphasize.

Anderson, Mayes, and Kibby (1995) described collaboration as an activity that is undertaken by equal partners who work jointly on the same problem rather than on separate components of the problem, indicating that group members are to work as a unit. Similarly, Roschelle and Teasley (1995) stated that "collaboration is a coordinated, synchronous activity that is a result of a continued attempt to construct and maintain a shared conception of a problem" (p. 24). In accordance with the CSCL emphasis, collaborative learning is defined here as the acquisition by individuals of knowledge, skills, or attitudes through group interaction in which group members share work and develop shared meanings about the group task (Derycke & D'Halluin, 1995).

The CSCL Perspective on Learning: The Social Production of Knowledge

The idea that collaborative learning is the development of shared meaning among group members reflects the larger CSCL perspective on learning, a perspective that emphasizes the social creation of knowledge as the basis of learning. Meaning is not pre-packaged and delivered to the student for memorization; rather, it is negotiated among group members (Pea, 1994; Roschelle, 1992). The student learns through actively participating in knowledge building as a member of a group and in the case of CSCL, through participation in an on-line group. For example, Scardamalia and Bereiter (1996), after stating that knowledge building is the creation of knowledge as a social product, asserted that knowledge building can be encouraged by having students actively contribute to and draw upon a communal, computerized database of knowledge.

Three components–collaboration, communication, and social context–are implied by the CSCL perspective on learning and are discussed in varying degrees by CSCL researchers. The social creation of knowledge, when discussed at the level of small groups, is collaborative learning or the development of shared meaning among group members. The collaborative development of shared meaning requires a substantial amount of communication, perhaps even more so in on-line than in face-to-face groups. Gay and Lentini (1995) described learning as being built through conversations between persons or among groups, involving the creation and interpretation of communication. Lastly, CSCL researchers have argued that the development of meaning does not happen independently from the social context

(Pea, 1994; Roschelle, 1992). The social context in which collaboration and communication occur inherently influences learning, and the on-line environment can offer a stronger sense of context than the standard classroom (Salaberry, 1996). As for the impact of CMC technology on these relations, Davies (1995) stated that learning remains a social/communicative activity, whether or not it is mediated over time and distance by communication technologies.

A Descriptive Model for CSCL Research

Researchers have yet to generate theory that connects all of the variables involved in computer-supported collaborations in educational contexts. In fact, Koschmann et al. (1994) stated,

> It is not totally clear, however, what constitutes a theory-based approach, especially because a variety of different types of theory come into play–theories of how people learn, theories of how an instructional system should best be designed to accomplish these ends, theories of social interaction, theories of how people and technologies can best function together, and so forth. (p. 228)

The model presented here provides a synthesis and integration of theory and research concerning CSCL. The structure of the model is based on three different models of group effectiveness: the Webb and Palincsar (1996) input-process-output model of group processes in the classroom, the O'Donnell and O'Kelly (1994) classification of collaborative learning theories, and the McGrath and Hollingshead (1994) input-process-output model of the impact of communication technologies on interacting groups. The resulting model includes inputs (social-behavioral, social-cognitive, course-CSCL fit, student variables), processes (behavioral and cognitive), and CSCL outcomes (positive academic and affective results), with CMC and instructor influences as variables moderating the relations between inputs and processes. An instructor designing a CSCL activity can use the model to identify pre-instructional decisions, desirable learning processes, ways to influence learning processes, and areas that may be problems during on-line group work.

The components of the CSCL perspective on learning are incorporated into the model. Collaboration is reflected in discussions of collaborative learning theory and through the notion that groups need a valid purpose if they are to function effectively. Communication issues include the need for on-line and group communication skills, selecting material that stimulates communication needed for learning, group processing discussions, and specific communication techniques that instructors can use to guide CSCL processes. The social context is examined in the model in terms of communication behaviors needed to create an on-line atmosphere conducive to group work. Details of the model follow, with examples of applications to communication courses.

Inputs to CSCL: Concepts and Pre-Instructional Decisions

Social-behavioral inputs. Social-behavioral inputs are derived from social-motivation and social-cohesion theories of collaborative learning (O'Donnell & O'Kelly, 1994). Collaborative learning, from the perspective of social-motivation theories, results from collective goals and rewards. Working with peers toward a common goal or reward increases each student's motivation to achieve. Group goals, commitment to those goals by group members, and individual accountability are the prerequisites of collaborative learning.

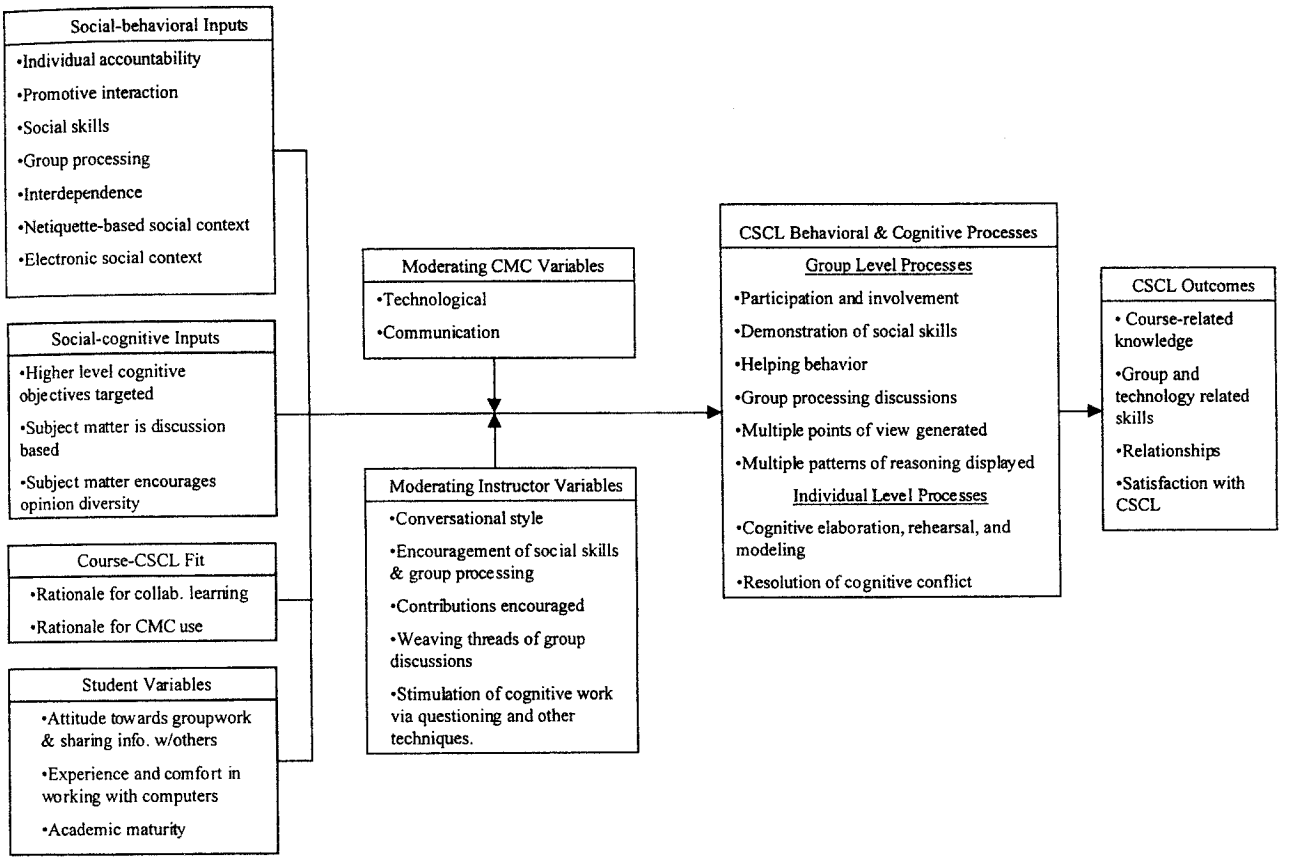

FIGURE 1.

A MODEL OF CSCL THEORY AND RESEARCH FOR INSTRUCTIONAL DESIGN.

Collaborative learning, from the perspective of social-cohesion theory, results from group identification which leads to concern for other group members and the wish to combine resources for the greater good. This perspective suggests that it is the student's identification with the group (assuming that a sufficient group identity is formed by group members), rather than goals or rewards, that is the source of student's motivation to learn. Drawing on research from these two approaches, Johnson et al. (1991) identified five elements that promote collaborative work in face-to-face groups: individual accountability, face-to-face promotive interaction, social skills, group processing discussions, and positive interdependence. These elements can be applied to on-line collaborative groups.

Individual accountability, in which both the individual and other group members are aware of the individual's performance toward the group task, is most closely tied to social motivation theory. It can be incorporated into the design of communication courses employing collaborative groups by keeping the group size small and by monitoring individual member's performance. Small groups of three to four people reduce the likelihood that members will free ride on the contributions of other members (Shepperd, 1993). Instructors can encourage the group to monitor individual member's performance to assure individual accountability in several ways. Individual quiz scores can be distributed to all group members. Instructors can generate individual grades on collaborative projects by having group members' rate each individual's contribution to the final group project. Discussions of progress toward project goals can be arranged periodically between instructors and groups.

Promotive interaction, social skills, and group processing discussions reflect most strongly the need for social cohesion (O'Donnell & O'Kelly, 1994). Promotive

interaction refers to quality of interaction among groups members and is reflected in such behaviors as group members helping one another, exchanging needed resources, providing appropriate feedback on performance, demonstrating trust and trustworthiness, and encouraging effort toward achieving the group goals (Johnson et al., 1991). Commitment to the group and psychological adjustment are most directly influenced by promotive interaction. At the beginning of group projects, instructors should introduce promotive interaction as the desired state of group interaction.

Social skills refer to the ability of each student to interact smoothly with others at an interpersonal or group level of contact. Instructors should not assume that students have the necessary social skills or communication competencies and may want to provide some training before a group project (Purdom & Kromrey, 1995; see Rubin, Rubin, & Jordan, 1997; and Spitzberg, 1989, for a review of communication competencies). Group processing refers to ongoing discussions by the group about how it is functioning and includes topics such as what behaviors need to be continued or eliminated to facilitate the productivity of the group. Instructors can formally require groups to go through this process or they can initiate this process informally by periodically meeting with each group (Johnson, Johnson, & Holubec, 1994).

Central to both of the social-motivation and social-cohesion approaches is the concept of positive interdependence. Positive interdependence means that group members must see value in working together for collaborative learning to occur (Johnson et al., 1991). Structuring positive interdependence in collaborative groups can be done through goal, reward, resource, and role interdependence. Goal interdependence involves setting collective goals. Reward interdependence involves collective rewards. Resource interdependence involves sharing common resources. Role interdependence involves the creation of complementary roles for each group member (Johnson et al., 1991; Johnson et al., 1994).

Each type of interdependence can easily be implemented in the design of communication courses employing collaborative groups. For example, instructors can establish reward interdependence by providing bonus points if all members reach a pre-set criterion or by combining group and individual scores in the calculation of grades. Instructors can create resource interdependence by distributing needed resources across group members, so that members need to communicate to gain access to those resources. Instructors can generate role interdependence by having groups negotiate specific roles for group members, such as recorder, devil's advocate, etc.

Social behavioral inputs and on-line groups. An important issue is whether instructors can usefully apply these elements of collaborative learning to the design of activities for on-line groups. The answer is yes. Individual accountability may be simpler to establish in the on-line environment, where all interaction and work submissions can be visible to all group members and preserved in a computer conferencing database function. For example, in a group communication course, an instructor could require that each group member post a summary of a group decision-making theory to the group computer conference by a set date. The summaries could then be referred to by the entire group as they worked towards a single co-written paper on decision-making strategies for on-line groups.

Instructors looking for templates of how interdependence and accountability can

be incorporated into course activities can review established methods such as: Student Teams Achievement Divisions (STAD) (Slavin, 1988, 1991), which uses class presentations, teams, quizzes, individual improvement scores, and team recognition to review materials; Teams-Games-Tournaments (TGT), which is similar to STAD except academic games are used in place of quizzes (Slavin, 1988; Webb & Palincsar, 1996); Jigsaw I and Jigsaw II, which are based on resource interdependence, peer tutoring, and whole-class activities (Clarke, 1994; Slavin, 1988); Group Investigation (GI), where student groups plan, carry out, and report on an investigation of a topic (Sharan, 1995; Sharan & Sharan, 1994); and Structured Academic Controversy (SAC), based on the resolution of debates by dyads and small groups (Johnson & Johnson, 1994, 1995; O'Donnell & O'Kelly, 1994). These established methods can provide ideas of how to make interdependence and accountability (and, in varying degrees, the other elements of collaborative learning) part of an on-line group project.

However, several characteristics of these methods limit their transferability to on-line activities. Specifically, the methods are all premised on face-to-face interaction, many are short time-frame activities, all are highly sequential and involve many steps, and with the exception of GI and SAC, all of the methods tend to emphasize drill and practice learning over shared development of ideas.

The social-cohesion argument that learning is aided when members identify with their group is mirrored in CSCL work, where researchers argue not only for social skills training but also for the development of an on-line social context that improves the educational experience. Many instructors have been concerned about the anonymity associated with on-line activities that can develop into the well-known problems of flaming, e.g., rudeness and other poor social behavior in on-line discussions (Berge, 1995). Reflecting on the collaborative learning elements of group processing, social skills training, and promotive interaction, CSCL researchers have suggested that activities such as getting acquainted on-line and team building provide guidelines for appropriate on-line behavior. Having members introduce themselves to one another, creating an e-mail address list for group members, and using member's names in all on-line communication can help groups to develop the social aspects of their on-line environment (Berge, 1995; Feenberg, 1989; Scalia & Sackmary, 1996).

Hiltz and Wellman (1997) found that asynchronous networks work best when they help create the feeling of a group learning together, which can be aided by getting-acquainted activities at the start of a project. Instructors can further develop the social environment for on-line groups by requiring regular group processing discussions in the design of the CSCL activity and describing a promotive on-line environment before group projects begin. Berge (1995) suggested that instructors reinforce good and punish bad on-line behaviors, avoid humor or sarcasm, and welcome lurkers and latecomers into discussions.

Instructors can also teach students about appropriate and inappropriate behavior in other on-line groups. McLaughlin, Osborne, and Smith (1995) provided a taxonomy of reproachable behavior on usenet. This taxonomy can be used as a set of guidelines by groups to establish effective on-line communication. It describes seven general types of reproachable behavior in on-line discussion groups: (1) incorrect/novice use of technology, (2) bandwidth waste which refers to excessively long or off-topic postings, (3) violation of networkwide conventions, (4) violation of

newsgroup specific behavior, (5) ethical violations, (6) inappropriate language, and (7) factual errors. The above activities are referred to in the model as netiquette-based social context development.

Another approach is to develop a social context for group work using simulations or metaphors to bring organization, meaning, and familiarity to the otherwise decontextualized electronic environment. Koschmann et al. (1994) argued that since learning is sensitive to perspective, goal, and context, instruction should involve authentic activities, settings, and objects of study as much as possible. Harasim (1991) described the use of campus, schoolhouse, or classroom metaphors to organize the on-line environment, with instructors referring to different on-line discussion areas as classes or conferences. For example, two recognized educational groupware programs, the CoSy Conferencing System (Kaye, 1995) and the Virtual Classroom (Hiltz, 1994), provide program interfaces built around campus and classroom metaphors.

If the CMC technology does not provide such an interface, simulations and metaphors can still be usefully applied. Providing students with problems based in simulations can draw on the penchant of students to adopt different personae when working on-line and can be more involving than a standard statement of a problem (Day & Batson, 1995). Koschmann et al. (1994) used computer conferencing and a problem-based learning format to engage medical students in a simulation of the team diagnosis and decision-making usually engaged in by doctors working in hospital settings. In the case of a communication course in which the major assignment is to design an experiment testing a theory presented in the course, an instructor could designate the on-line computer conferencing environment as the "group research facility," with separate "rooms" in the facility for on-line discussions about theory, method, data analysis, and report writing.

In summary, the social-behavioral inputs of the model are designed to increase student participation and involvement and to create a productive and comfortable social environment for collaborative work.

Social-cognitive inputs. The term "social-cognitive" refers to the influence of the social environment produced in on-line collaboration on individual learning. Cognitive theories of collaborative learning include the developmental theories of Vygotsky and Piaget and cognitive-elaboration (O'Donnell & O'Kelly, 1994). In the Vygotskian view of cognitive development, an individual's cognitive structures develop through a process of mediation and modeling of the cognitive structures of other people demonstrated during communication. A caveat is that the cognitive structures of other people must be within the individual's zone of proximal development for modeling to take place, i.e., within the range that the individual can be expected to comprehend.

In Piagetian cognitive-developmental theory, cognitive structures develop through the resolution of cognitive conflicts that are generated during peer interaction. In cognitive-elaboration theory the emphasis is on the cognitive processing of interacting individuals; interaction with others leads to active processing of information by the individual, which in turn modifies the individual's cognitive structures. The term "elaboration" refers to detailed explanations of a subject, such as when students provide specific examples to illustrate concepts, use multiple representations (charts, figures, pictures, etc.) to explain a concept, create analogies, translate terms, provide detailed descriptions of how to perform tasks or the differences between two

concepts, provide detailed justifications of their problem-solving, or use observations and evidence to support opinion or belief (Webb & Palincsar, 1996). Elaborations can benefit both the elaborator and the other student(s) in the conversation (Webb & Palincsar, 1996).

The three social-cognitive theories agree that learning is a result of interaction. In Vygotskyian theory, learning occurs during interaction when students are exposed to a slightly higher level of difficulty than what they have already achieved cognitively. In Piagetian theory, learning occurs through interaction that produces multiple perspectives that, in turn, generate cognitive conflict in the individual student. Lastly, cognitive-elaboration theory requires interaction as a venue for demonstrations of and exposures to elaborations, rehearsals, and reorganizations of concepts.

The interactive, discussion-based emphasis found in the social-cognitive theories of learning suggest that some courses and course content will be more suitable to CSCL work than others (Kaye, 1989). Course content can be broken down into cognitive objectives using the Bloom (1956) taxonomy of six increasingly difficult levels of cognitive objectives–knowledge, comprehension, application, analysis, synthesis, and evaluation respectively. The first three levels of objectives–knowledge, comprehension, and application–involve simpler mental tasks such as memorization, basic translation, and applying simple rules or concepts. The analysis, synthesis and evaluation levels represent more complex cognitive tasks, such as separating or combining concepts and making judgments based on evidence. It is higher-level cognitive tasks that CSCL researchers have suggested are appropriate for on-line discussion-based learning.

Courses that require students to memorize or master a great deal of information or specific skills may not be appropriate for on-line collaborative learning (Berge, 1995; Hiltz, 1994). Cognitively complex course content is best suited for the discussion-based learning facilitated by group computer conferencing. Additionally, the social-cognitive perspective suggests that selecting debatable topics–controversies, issues with two or more defined points of view–may be best for CSCL work, since multiple perspectives are considered helpful to the learning process. Methods for organizing multiple perspectives include the previously described Group Investigation and Structured Academic Controversy, each of which can serve as a general template for structuring controversy into a lesson plan.

In sum, the social-cognitive perspective suggests that instructors should evaluate the content of their course before employing collaborative on-line groups and should select topics that are complex enough to encourage on-line discussion and the consideration of multiple viewpoints.

Course-CSCL fit. Developing an appropriate rationale for CSCL activities requires that instructors find or develop reasons why students should work in groups and why those groups should use CMC technology. Students may be reluctant to participate in CMC group discussions if they perceive the on-line activity as extra work that is not pertinent to classroom learning (Witmer, 1998). A similar point of view is expressed by Nalley (1995), who stated, "If teachers are unable to make clear to their students the value of the CMC portion of the course, students will likely reject CMC as nothing more than technological game playing. And they will be right" (p. 14). Instructors need to take steps to make sure that CSCL is tightly integrated into the

structure of the course and that students understand how CSCL relates to course goals.

One way to provide a rationale is to demonstrate how on-line groups can lead to a better understanding of the course material. Nalley (1995) described how use of on-line groups was justified in a course on computers and education on the basis that training in using computers to communicate with group members was needed for understanding of the course content. Hiltz (1994) indicated that students may be more receptive to CSCL activities and perform better in on-line activities in courses where computer use is a norm. Similarly, Witmer (1998) described the use of CMC as part of an experiential learning design, where students utilized an Internet-based technology as a means of learning communication concepts.

There are many options for connecting the content of a communication course with CSCL activities. Instructors of interpersonal communication courses can illustrate the strong impact of nonverbal and paralinguistic cues in interaction by having students participate in both face-to-face and computer-mediated group discussions and comparing students' impressions in the two communication environments. Instructors of business communication courses can have small groups of students work together on-line to edit and develop a written business proposal. Students would gain valuable experience with the sorts of word processing technologies and on-line collaborations that they are likely to experience on the job. Instructors of argumentation courses can illustrate the development of arguments and consensus by using on-line groups. Students can be assigned into small groups to debate and then asked to reach a consensus position on an issue via a computer conferencing system. Because computer conferencing maintains a text record of all premises, claims, and persuasive efforts that may have occurred during the debate and reconciliation, the instructor can use arguments created by the students themselves as examples to illustrate important course concepts.

A second means of providing a rationale for CSCL use is based on student accessibility to each other during a course. Nalley (1995) found that the need of commuter students to communicate with each other provided a reason to use groupware in a course because students could not easily meet face-to-face. A more elaborate means of providing a compelling rationale for CSCL is described in studies by Wheeler, Valacich, Alavi, and Vogel (1995) and Gay and Lentini (1995), where inter-institutional relationships were formed in which teams composed of students from different universities utilized groupware tools to complete a project. Developing such distance-learning situations may provide the strongest rationale for students to use groupware, but also requires a substantial amount of planning and monitoring on the part of the participating instructors.

In most classroom situations on university campuses, students are co-present and the course topics do not mesh naturally with CSCL. In these situations, a credible rationale for using on-line groups becomes more difficult. Because computer technologies and the Internet are transforming how groups are defined and how they communicate in organizations and in communities, instructors may want to position on-line collaborations in the course as giving students valuable experience with communication technologies that will prepare them for their future careers. Corporations are increasingly making use of virtual teams (Lipnack & Stamps, 1997), and CSCL activities can help prepare students to work in these new organizational units. Students entering sales positions may need to communicate with other sales agents

and regional managers using on-line technologies. Because communication technologies are changing higher education, students aspiring to be teachers, corporate trainers, or university professors will need to be proficient with on-line groups.

When introducing the notion of on-line groups in communication courses, instructors can describe new group forms that have emerged in organizations and on the Internet, e.g., virtual teams and news groups, and discuss some of the research comparing face-to-face and computer-mediated interaction. For example, in an organizational communication course, instructors can have students visit web sites devoted to group decision-making and team building such as those provided by the University of Illinois at Urbana-Champaign and Clemson University (Witmer, 1998). Instructors can stress the career and skill development aspects of working in an on-line team by pointing out the growth of virtual teams and discussing the skills needed to be effective in an on-line team.

Student variables. Another area of inputs to consider prior to the use of CSCL activities is the characteristics of the students who will be involved in the activity. Research indicates that students' comfort with group work and technology, and some other personal variables, influences student performance (Hiltz, 1993, 1994; Witmer, 1998). Studies of collaborative learning in the standard classroom setting indicate that not all students work well in collaborative learning environments. Students inclined to cooperate did best in cooperative settings; students inclined to work by themselves did best in traditional whole-class or individual settings, and students who preferred to compete did best in competitive settings (Webb & Palincsar, 1996). Similarly, some students may not like the collaborative aspects of CSCL. Scalia and Sackmary (1996) noted some student resistance to use of groupware because of a general preference against working in groups or a lack of comfort in sharing information with others.

There may also be resistance to CSCL based on student comfort with the use of CMC technology. Althaus (1997) found that e-mail users were more likely to engage in voluntary computer-mediated discussions than non-users. Hiltz (1994) found that students with more positive attitudes toward computers at the start of an on-line course spent more time on-line, logged-on more frequently, and indicated that they would take another on-line course. However, over time, students initially resistant to the use of CMC technology may change their attitude. Scalia and Sackmary (1996) noted that as students become familiar with the technology used for on-line communication, their attitudes toward CSCL improve.

Other individual characteristics may influence students' participation in CSCL. A study of the Virtual Classroom by Hiltz (1993) concluded that students with a high level of academic maturity (as measured by class standing and SAT scores) had more positive outcomes, as did self-motivated and self-disciplined students. In sum, instructors will have more success with students who are comfortable with computers and learning in groups and have a high level of maturity.

Moderating Variables

As indicated in the model, the relation between inputs and the resulting behavioral and cognitive processes is moderated by features of the communication technology and the instructor. The motivational features, cognitive objectives, rationale, and student characteristics will have little impact if the CMC technology interferes with communication among group members.

Communication technology. Communication technology variables include the features and reliability of the conferencing system. According to O'Malley (1995), asynchronous computer conferencing, a basic form of groupware in which groups have an electronic space in which to leave messages and information, is the dominant and preferred CMC technology in both co-located and distance learning settings. More elaborate groupware programs may include options for group scheduling, project management, desktop video conferencing, and workflow routing.

There is a general agreement among CSCL researchers that on-line groups should be provided with as many groupware options as possible, in terms of the number of communication channels and the symbol-carrying capacity of the channels (Berge, 1995). A study by Gay and Lentini (1995) of student groups using multiple channels of CMC technology available (chat tools, drawing tools, video/audio conferencing) revealed that groups used different channels in different ways to increase the depth and breadth of their interaction, suggesting that on-line groups will be more productive when provided with multiple communication modalities.

As for symbol-carrying capacity, the text-based nature of most CMC technologies can limit the content that can be taught using on-line groups. For example, Hiltz (1994) found that courses requiring visual material, manipulation of physical objects, or audio interaction needed to offer supplemental media to students. Pea (1994) argued that CSCL will not advance until greater multimedia capabilities that allow multiple representations and non-text symbol transmissions are available.

Other important considerations about technology are: the reliability of the server and the software, the technical support available for the students, ease of use of the system, training needs, and access to the system by students. If the software/hardware system used for CSCL presents students with too many obstacles, they may not get on-line enough to become proficient with the groupware system (Scalia & Sackmary, 1996).

Computer-mediated communication can change the nature of group interaction (for a review, see McGrath & Hollingshead, 1994). It presents initial users with a "leaner" form of communication. New on-line groups take time to adjust to the new technology and often do not perform as well as face-to-face groups (Hollingshead, McGrath, & O'Connor, 1993). New discursive environments are produced by CMC due to the lack of nonverbal communication, greater individual involvement, and the new set of turn-taking skills required by computer conferencing (Salaberry, 1996). However, over time, studies have shown that on-line groups can perform cognitive tasks as well as face-to-face groups (Hollingshead et al., 1993).

The areas of most concern to educators are the impacts of CMC on student participation and learning. Studies suggest that use of on-line groups will most likely increase student participation. Alavi (1994) and King (1994) found that because CMC encourages peer-to-peer interactions outside of the traditional classroom, it can increase learner satisfaction and engagement in the learning process. Use of CMC can also reduce some barriers to participation that are present in face-to-face groups (Bannon, 1995; Koschmann, 1994). For example, Bonito and Hollingshead (1997) found in a review of the literature on participation in groups that members' status affected the degree to which they participated in face-to-face groups. High status members participated much more than low status members. To the extent that CMC-based interaction tends to reduce the salience of status and demographic

differences among participants, group members may feel more comfortable participating and in turn garner more cognitive gains when they interact with others on-line (Kiesler & Sproull, 1992).

Another concern about CMC activities is that the lack of social cues in the electronic environment may retard the development of a sense of community and identity among group members and that negative communication (i.e., flaming) may be an on-going problem. However, studies by Walther and his colleagues (Walther, 1992, 1996; Walther, Anderson, & Park, 1994; Walther & Burgoon, 1992) demonstrated that positive interpersonal relationships can develop in on-line groups when time limits are not restrictive.

The asynchronous nature of computer conferencing slows the progress of on-line groups on their assigned tasks. On-line groups take longer than face-to-face groups to make decisions, even when they are communicating synchronously (McGrath & Hollingshead, 1994). Berge (1995) found that on-line groups generally produce two to three well-articulated points per month in their discussions. These studies suggests that instructors should not expect the same rate of progress as found in face-to-face groups. More time should be allowed if on-line group projects involve multiple stages or steps, since on-line groups commonly experience difficulties with task coordination (Berge, 1995; Harasim, 1991). Instructors can help groups manage time issues by including milestones and deadlines in the design of the group project (Scalia & Sackmary, 1996).

Instructor influences. The instructor can encourage and augment behavior and cognition in CSCL groups. Overall, instructors need to appreciate that using CSCL changes the role of the instructor from expert presenter of information to discussion facilitator and manager, a change in position which also requires a different set of teaching skills (Berge, 1995).

Instructors can encourage desirable group behaviors by requiring that students make regular contributions to the group discussion and by coaching students on their communication skills (Berge, 1995; Harasim, 1987). As for the general tone of instructor comments, Ahern et al. (1992) found that a conversational style of discourse was more effective than using only questions or statements.

There are also several techniques instructors can use to stimulate cognitive processing in on-line groups. One such behavior is termed "weaving," which refers to the instructor guiding group discussion by summarizing the state of the discussion in a group and by identifying unifying themes or points of disagreement apparent in the threads of the group discussion (Feenberg, 1989). Instructional "scaffolding," a technique based in Vygotskian theory in which the instructor tapers off support from an initially high level, has proven beneficial in traditional collaborative groups (Smagorinsky & Fly, 1993). This could be done in on-line groups.

A number of techniques for encouraging and guiding the content of on-line group discussions are described by Elsley (1991), such as "go around the circle" in which all participants are asked to respond individually to a question before a new question is addressed, assigning debates within the group, and free association. While groups may function without instructor input, it is likely that their performance would be less than optimal.

In summary, the relations between inputs and learning processes will be moderated by the characteristics and reliability of the groupware provided to on-line groups and by the role the instructor takes in the on-line group. The nature of CMC

communication may increase participation, but is likely to slow social and task progress made by on-line groups.

CSCL Processes

The variables identified as processes in the model reflect the social and cognitive behaviors desirable in a CSCL activity at the level of the group and at the level of the individual. The group level processes identified in the model include what the social-behavioral, course-CSCL fit, and student input variables are most likely to influence–participation and involvement, demonstration of netiquette-based social skills, and group processing discussions. Also included under group processes is the generation by the group of what the social-cognitive perspective requires for learning–the display of multiple points of view and patterns of reasoning which the individual student can then draw on for cognitive processing.

Listed as individual level processes are those processes identified in social-cognitive perspective as leading to cognitive change within the individual–elaboration, rehearsal, and modeling, and the resolution of cognitive conflict. The group and individual processes are assumed to be highly interwoven. For example, the opinions generated by the group induce cognitive conflict within the individual, who may then contribute an elaboration of his or her own point of view back to the group discussion.

Since the processes identified in the model are derived from collaborative learning theory, the question is whether these group processes in fact appear in CSCL group interaction. The answer is yes, but there are some differences from face-to-face groups due to the CMC interface. Ruberg, Moore, and Taylor (1996) found that CMC-based interaction encouraged sharing of ideas, more and broader participation, and collaborative thinking by students, though some students did not adjust to the CMC format. Scalia and Sackmary (1996) showed that while on-line groups may take longer, their interchanges can be more rich in content and complexity than standard classroom interaction. Salaberry (1996) demonstrated that the new discursive environment created by groupware produces a pattern of communication that forms over a longer period of time and that is more complex than face-to-face groups, because students have more time to reflect on their responses.

CSCL Outcomes

Collaborative learning in standard classrooms can have powerful effects on numerous cognitive and affective outcomes, including academic achievement, cognitive development, intergroup relations, self-esteem, motivation and anxiety (Ahern et al., 1992; Alavi, 1994; Courtney, Courtney, & Nicholson, 1994; Johnson et al., 1991; Slavin, 1991; Webb & Palincsar, 1996).

Research on CSCL indicates similar outcomes for on-line groups, suggesting that the beneficial outcomes of standard collaborative learning can occur in computer-mediated settings (Witmer, 1998). Hollingshead et al. (1993) found that face-to-face groups outperformed computer-mediated groups at the outset of a semester, but after three weeks there were no significant differences in group performance across the two types of groups. An evaluation by Hiltz (1993, 1994) of the Virtual Classroom groupware program attributed associated positive learning outcomes with the use of collaborative learning. Scardamalia & Bereiter (1994) evaluated the

CSILE (computer-supported learning environment) program and found that collaborative learning facilitated knowledge building by student communities. Though not on-line courses, Alavi (1994) and McManus and Aiken (1995) indicated success combining the use of groupware systems and the modified Student Teams Achievement Divisions and Jigsaw collaborative learning methods that were described earlier.

It is important for instructors to develop assessments of the knowledge and satisfaction that students are gaining in the on-line collaborative environment. This can be done through observations of on-line discussions, through periodic quizzes or essays on course-related topics, and through obtaining students' reactions to the on-line environment via surveys given at the beginning, middle, and end of the semester.

Discussion

As the availability of on-line group communication tools in higher education increases, so too will the need of instructors for information on how to best use these tools for learning. Theoretical and empirical research related to the use of on-line groups for instructional purposes (CSCL) was reviewed using a descriptive model. As this review indicates, designing and managing CSCL activities involves the complex interplay between the basic elements of a collaborative learning experience, features of the groupware used, the rationale behind the use of CSCL in a course, instructor influences, and student characteristics.

Effective use of collaborative learning in an on-line environment requires attention to issues of motivation and identity in the on-line group. Activities should be designed to generate multiple viewpoints and patterns of reasoning that challenge the cognitive skills of each group member. While CMC can be expected to modify communication as compared to standard face-to-face groups, the outcomes associated with CSCL should be positive, particularly if the groups work together over a period of time and the instructor actively manages on-line interaction.

A first step for instructors may be to consider the scope or role CSCL will play in a course. Will CSCL act as a substitution, as a supplement, or as a complement to regular instruction? If CSCL totally replaces the regular means of teaching a topic, it is serving as a substitution. Alternatively, if regular instruction is maintained and a CSCL activity is added, CSCL has a supplementary role. Lastly, the instructor might interweave instruction and CSCL, e.g., some of the regular instruction is maintained in the form of a lecture by the instructor while the remainder of the instruction is placed into a CSCL activity. If CSCL seems to be appropriate in a course only as a minor, supplemental activity, the instructor may wish to consider whether the activity merits the amount of preparation and participation required.

Ultimately the role of CSCL in higher education is in the hands of instructors, not in the growing array of CMC technologies. And given the communication-based nature of CSCL, communication scholars belong at the forefront of the next generation of CSCL research.

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