# Concepts of Communication in CSCL

## THEORIES OF COMMUNICATION

In general, there are many theories of communication. Littlejohn (1999) lists nine broad categories of communication theories, that can be characterized as follows:

- *Cybernetics* – calculates the flow of information between a message sender and a message recipient, allowing for effects of feedback and transmission noise.
- *Semiotics* – analyses the role of signs, symbols and language in communicative interaction.
- *Conversation analysis* – identifies structures of ordinary conversation, such as turn-taking and question-response pairs.
- *Message production* – considers how message production is determined by the personal traits and mental state of speakers and by the mental processes of producing the message.
- *Message reception* – focuses on how individuals interpret the meaning of communicated messages, organize the information they receive and make judgments based on the information.
- *Symbolic interaction* – views group, family and community social structures as products of interaction among members; the interactions create, define and sustain these structures.
- *Socio-cultural approach* – emphasizes the role of social and cultural factors in communication within or between communities.
- *Phenomenological hermeneutics* – explores issues of interpretation, such as problems of translation and historical exegesis across cultures.
- *Critical theory* – reveals the relations of power within society that systematically distort communication and foster inequality or oppression.

These various kinds of theories focus on different units of analysis: bits of information, words, verbal utterances, communicative messages, social interactions, communities, history and society. Although traditional communication theories taken together address both individual and social views of communication and take into account both face-to-face and technologically-mediated communication, they do not directly address the particular combination of concerns in CSCL. CSCL by definition combines technical, collaboration and learning issues, and does so in novel ways.

The very phrase, "collaborative learning" combines social and individual processes. The term "learning" is generally taken as referring to individual cognitive processes by which individuals increase their own knowledge and understanding. The collaborative aspect, on the other hand, explicitly extends learning to groups interacting together. Recent discussions also talk about "organizational learning" and "community learning." Furthermore, contemporary pedagogical research literature emphasizes that even individual learning necessarily takes place in social settings and builds on foundations of shared or intersubjective knowledge.

## PHILOSOPHIC THEORIES

Our accustomed ways of thinking and talking about learning tend to center on the individual as the unit of analysis. This common sense or folk theory view can be ascribed to traditional Western philosophy, which since Socrates and especially since Descartes has taken the individual as the subject of thought and learning. The variety of twentieth century communication theories can be seen as a heritage of different philosophies that arose in previous centuries. Foundational theory used to be the provenance of philosophy, but has recently become the task of interdisciplinary social sciences, including communications. As diagrammed in Figure 1, philosophies prior to Hegel provided foundations for the learning sciences focused on the knower as an individual. Hegel (1807/1967), however, tied knowledge to broad social and historical developments. Marx (1867/1976) then grounded this in the concrete relationships of social production, and Heidegger (1927/1996) worked out its consequences for a philosophy of human being situated in worldly activity. Sociologists,

anthropologists, computer scientists and educators have extended, adapted and applied these approaches to define pedagogical theories relevant to CSCL.

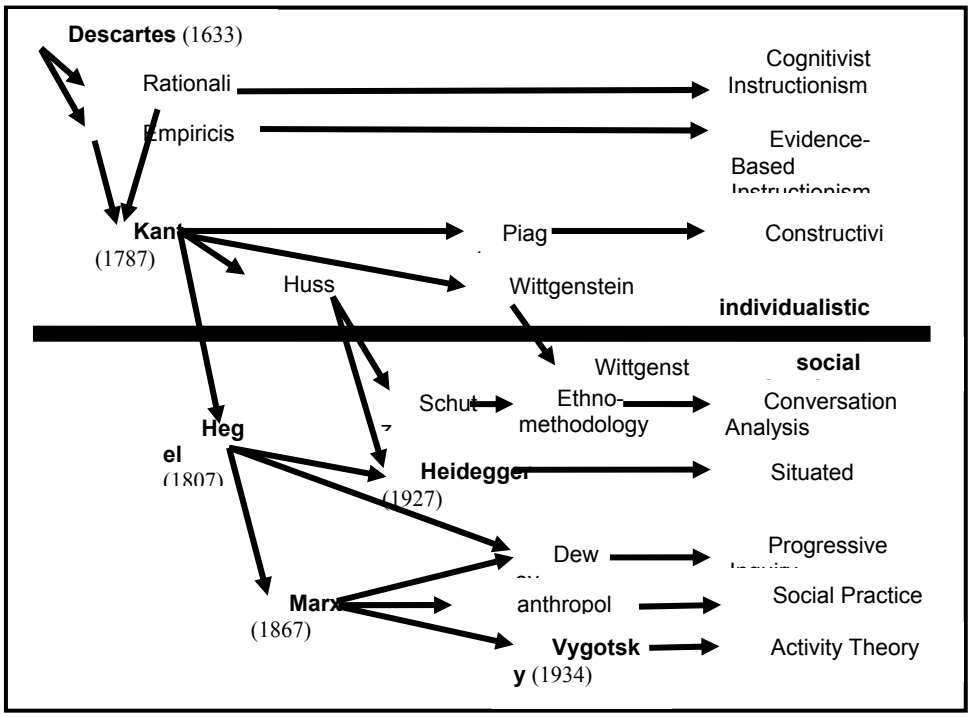


Figure 1. Philosophic sources of individual and social theories of learning

## THEORIES OF LEARNING

Different theories of learning are concerned with different units of analysis as the subject that does the learning. Traditional educational theory, such as that of Thorndike (1914), looks at the individual student and measures learning outcomes by testing for changes in the student's behavior after a given educational intervention. From such a perspective, pedagogical communication consists primarily of an instructor conveying fixed knowledge to students.

In the 1950's and 1960's, there was considerable research on learning in small groups (Johnson & Johnson, 1989). This was, of course, prior to interest in computer support for learning. While it was

still generally assumed that the important learning was that which the individual student retained, there was explicit concern with the interactive processes within small groups of learners working together. It was clear that the group activities had to be structured carefully to promote cooperation, inter-dependence and learning; and it was recognized that participants had to learn how to cooperate effectively as well as learning the subject matter.

A more radical redefinition of learning took place with the analysis of situated learning within communities of practice (Lave, 1991). Here, the life-cycle of a community was taken as the primary learning process, and the learning of individual community members was defined by the trajectory of their roles within the evolving community. For instance, even a relatively stable apprenticeship community can be seen as a group learning situation, in which new members gradually become acculturated and promoted. This view spread to the business world as it became concerned with the nature of corporations as "learning organizations" in a knowledge society (Argyris & Schön, 1978).

With the advent of the Internet, it became obvious that technology might be useful in providing new communication media for learning communities. CSCL was founded based on the idea that classrooms could be structured on the model of professional communities of practice that collaboratively built knowledge, such as scientific theories (Scardamalia & Bereiter, 1996). New CSCL communication environments would structure student contributions to online threaded discussion into knowledge building processes of collaboration.

The new communication theory was founded on a constructivist theory of knowledge: knowledge was no longer viewed as a body of facts that teachers could package as explicit messages for reception by students, but more as a subtle developmental process in which students had to construct new understanding based on their current conceptualizations (Papert, 1980). Furthermore, following the principles of Vygotsky (1930/1978), knowledge was seen to be generally constructed socially in interactions among people before it was internalized as individual knowing. This social aspect was further developed into activity theory by Vygotsky's followers, emphasizing that individual cognition is mediated by physical and symbolic artifacts and that it centrally involves socio-cultural aspects.

The goal of providing effective computer support for collaborative learning is complex. Software cannot be designed to support a simple model of communication, but must take into account interactions among many people, mediated by various artifacts, and pursuing pedagogical goals at both individual and community levels. The software itself can be conceptualized as a mediating artifact of collaborative communication: the technology introduces physical constraints as well as sophisticated symbolisms (e.g., technical terms, icons and representations of procedures like links). This means that students must learn how to use the CSCL artifacts and that the technology must be carefully integrated into pedagogical activities. CSCL researchers trying to understand how to design classroom pedagogies, computer support and evaluation methodologies have had to turn to an assortment of theories of communication, education and cognition, such as collaborative interaction, constructivism, knowledge building, situated learning in communities of practice and activity theory.

## ELEMENTS OF CSCL COMMUNICATION THEORY

The circumstances of computer supported collaborative learning introduce a number of significant and interacting factors into the communication process. Most of these factors have occurred before separately: telephones eliminate face-to-face visual contact; letter writing is asynchronous; group meetings exceed one-on-one interaction; TV and movies add technological manipulation of messages. However, CSCL simultaneously transforms the mode, medium, unit and context of communication.

*The mode of CSCL communication*. CSCL may mix many modes of communication, including classroom discussion, small group meetings, threaded discussion forums, chat and email. Typically, it relies heavily upon threaded discussion. This mode is asynchronous and allows everyone to participate at their own pace; it can foster reflective responses and equality of participation. However, the volume of communication and the computer context with its restriction to typed text also encourages quick responses with short messages. The asynchronous nature of this mode slows down communication and makes it difficult to make timely group decisions and meet short

deadlines. Chat can speed up interaction, but increases the pressure to respond quickly. If more than a couple of people are chatting, the structure of responses can become confused. In general, each mode has pros and cons, so that a careful mix of modes can take advantage of the affordances of each.

*The medium of CSCL communication*. The computer-based medium has inherent advantages. First of all, it provides a persistent storage for documents, messages and interaction archives. A well-integrated collaboration environment can help users to review, browse and integrate records of related interactions from different modes – and associate them with relevant digital artifacts, like diagrams, graphs, data, pictures and reports. The computer can also lend computational power, manipulating, organizing, processing and displaying information in alternative ways. For instance, messages can be displayed by thread, chronology, type or author. The more functionality a CSCL environment offers, the more users have to learn how to use it: how to understand and manipulate its interface and how to interpret and take advantage of its options. The computer environment can be a mysterious, confusing, frustrating and foreboding artifact with arcane symbols and tricky functions – particularly until one masters the tool. Mastery of the medium often involves understanding some aspects of the technical terminology and model that went into the design of the medium and that is reified in its interface.

*The unit of CSCL communication*. Collaborative learning often focuses on the small group of perhaps four or five students. The students learn by brainstorming, sharing information, reacting to each other's utterances, discussing, negotiating decisions and reaching common conclusions. The group learns something as a group and as a result of the group process – something that no member of the group would have come up with individually and perhaps something that no member will quite leave with. Of course, a group is made up of its members, who bring their own backgrounds, perspectives, prior knowledge and contributions to group discourse, and who also take with them what they have learned from the group interaction. So there is an individual unit of learning that is tightly coupled with the group unit. Perhaps just as importantly, the group activity is embedded in the larger contexts of a classroom, a school, a society. The goals of the group activity (tasks, rewards), its constraints (materials, time), its medium (computer support, meetings), its division of labor (group

selection, mix of skills) and its social practices (homework, native language) are given by the larger community beyond the group itself. The individual, group and community all develop new skills and structures through the influence of one unit upon the other; none is fixed or independent of the others; learning takes place at each unit and between them.

*The context of CSCL communication*. CSCL communication takes place primarily through discourse. Discourse is a sequence of utterances or short texts in a spoken or written natural language like English. Spoken language is quite different from standard written language: it does not consist of refined, complete, grammatical sentences, but includes many halting, ambiguous, garbled phrases. The significance of spoken utterances is largely determined by the subsequent discourse. If some phrase or meaning is problematic for the people interacting, they may engage in a sequence of interactions to repair the problem. Chat tends to be similar to spoken language, but it has its own conventions. Threaded discussion is more like written language, although it is still interactive so that the meaning is determined by sequences or threads of messages from different people. In collaborative learning, one should not assume that an utterance is an expression of some well-defined thought in the mind of an individual, but should construct the meaning interactively from the on-going interaction of utterances – much as the members do while collaborating. The discourse context is embedded in the larger activity context, including various layers of community. This larger context includes an open-ended network of physical and symbolic artifacts (including technology and language), whose meanings have been established through histories of use and have been passed down as culture. Collaborative discourse is situated in the shared understanding of the group members, which in turn is historically, socially, culturally situated.

## IMPLICATIONS FOR EMPIRICAL ANALYSIS OF COLLABORATIVE COMMUNICATION

The complexity of communication in CSCL implies that empirical assessment of collaborative learning should take place on the

individual, group and community levels of analysis and should show how these interact. Here are some common approaches:

*Individual outcomes*. Perhaps the most often used approach is the traditional measurement of individual learning outcomes under controlled conditions. For instance, individual students might be given a pre-test prior to completing a collaborative learning task. Then a post-test is administered to see if there was a statistically significant improvement under various conditions. Extreme care must be taken in defining comparable conditions. For instance, it is probably not possible to compare conditions that are collaborative to individual, or computer-mediated to face-to-face because the tasks under those different conditions are necessarily so different: the activity task either involves or does not involve interactions with other group members and/or with computer software.

*Thread statistics*. Group discourse in a threaded forum is often measured by compiling thread statistics. For instance, the number of postings per day or week shows the level of activity during different phases of a project. The distribution of thread lengths can give an indication of the depth of interaction. This kind of communication measure is especially appropriate for comparing similar cases, rather than for making absolute measurements, since thread statistics will be very dependent upon factors like teacher expectations and grading schemes. Thread statistics provide a convenient quantitative measure of discourse; they can give some comparative indication of what is going on, although they are not very meaningful in themselves.

*Message coding*. A method of quantifying a measure of the quality of discourse is given by coding schemes. Discourse utterances can be coded according to their content or their style. For instance, one could determine the primary topics in a discourse and classify the individual utterances under these topics. Then one could see who discussed what topics when. Or one could classify the utterances according to a set of categories, like: new idea, question, argument, summary, off-topic, greeting, etc. Analysis of coded utterances can shed light on aspects of group process. Of course, it cannot follow the development of a group idea in any detail.

*Discourse analysis*. This is a labor-intensive detailed analysis of an interaction based on a close interpretation of a sequence of utterances. It requires some familiarity with the structure of interaction, such as turn-taking, floor control, repair strategies. These structures are quite

different in computer-mediated modes of communication than in the face-to-face situations that have been most analyzed. Despite its difficulty, this method of empirical analysis is the most likely to yield a detailed understanding of the group learning that has taken place. This is because the learning has necessarily been made visible in the discourse. In order to conduct successful collaboration, the evolving state of knowledge must be visible to all members in the group discourse; this evidence of learning is retained in the traces of discourse if they have been adequately preserved and properly interpreted.

*Role of artifacts*. Most collaborative activities involve more than the core discourse. The discussions often revolve around coming to increased understanding of a physical or digital artifact – for instance a printed book or a computer simulation. The artifacts are embodiments of meanings that have been embedded by the artifact designers or creators; new users of the artifact must bring those meanings back to life. This is often an important part of a collaborative task. A full analysis of collaborative learning should consider the role of artifacts in communicating meaning – possibly across generations, from creator to user – and the process by which groups learn to interpret that meaning.

## IMPLICATIONS FOR TECHNOLOGICAL SUPPORT OF COLLABORATIVE COMMUNICATION

Computer support of one-on-one communication is well understood. Systems like email may not be perfect, but they do the job for most people. Collaborative communication is much harder to support, because it involves sharing across multiple perspectives.

*Shared learning place*. The starting point for a CSCL environment is a shared repository and communication center, such as that offered by CSCW systems (computer support for cooperative work). However, CSCL is different from CSCW because learning situations are different from work situations in several important ways: there is a teacher who structures goals and activities to facilitate learning rather than for economic ends; the school's culture differs from the commercial culture in terms of methods and rewards; the group members in collaborative learning are novices in the field they are studying, compared to the professional experts in cooperative work.

*Shared meaningful media*. The computer support media and the curricular content materials convey meanings that group members must learn and come to share.

*Social awareness*. In communication that is not face-to-face, there should be mechanisms to support social awareness, so that participants know what other group members are doing, such as whether they are available for chat.

*Knowledge management*. A variety of tools should be provided to help groups organize the information and artifacts that they are assembling and discussing. These tools should allow knowledge to be organized by the group as a whole, so that everyone can see the shared state of knowledge as well as possible individual arrangements.

*Group decision support*. In order to arrive at a body of shared knowledge, group negotiation and decision-making must be supported. There should be mechanisms that foster both divergent brainstorming and convergent consensus building.

## IMPLICATIONS FOR PEDAGOGY OF COLLABORATION

The nature of CSCL communication suggests that curricula be structured much differently from traditional didactic teaching, lecturing, rote practice and testing.

*Support for group discourse*. The centerpiece of collaborative learning practice is the promotion of group discourse. Group members must be able to engage in a variety of modes of discursive interaction. This is the way that knowledge is constructed at the group level.

*Scaffolding*. The teacher's role is to scaffold the group discourse. This means providing tasks, structure, guidance and supports. These are offered primarily at the beginning. As the students learn how to direct their own collaborative learning, many of these supports by the teacher can be gradually withdrawn, like the superstructure of scaffolding around a building under construction that is removed when the building can stand on its own. The teacher functions mainly as a facilitator of learning, rather than as a source of knowledge.

*Pedagogical situations*. The definition of goals, tasks, media and resources is critical to the success of collaborative learning. Designing and implementing effective pedagogical situations or opportunities for

collaborative learning is the subtle and essential job of the teacher. Especially in the early stages, the teacher must also guide the students through the collaboration process, modeling for them how to focus on key learning issues and how to frame manageable tasks. Often, a teacher's guiding question will define an impromptu learning occasion.

*Groups and communities*. Ultimately, individual students should grow into positions of skillful leadership within the larger learning community. Practice within small groups builds that capability. In many ways, the small groups mediate between the individuals and the community, providing a manageable social setting for students learning interaction skills and structuring an amorphous community into specialized units.

*Learning artifacts*. Artifacts are units of past knowledge-building, externalized and made permanent in some physical, digital or linguistic form. They facilitate the passing down of knowledge from one generation of collaborative learners to another. By learning to interpret the meaning of an artifact, a new group discovers the knowledge that a previous group stored there. Pedagogical situations should contain carefully designed learning artifacts.

*Problem-based learning*. An illustrative pedagogical method for collaborative learning is problem-based learning for medical student (Barrows, 1994). Groups of students work with a mentor who is skilled in collaborative learning and offers no medical information. During their course of study, students engage in a series of medical cases that has been carefully designed to cover the field of common medical issues. Students discuss a case in a group and then individually research learning issues that their group identifies, coming back together to explore hypotheses and develop diagnoses. Exploration of a case involves deep research in medical texts and research literature. The case itself is furnished with rich artifacts like patient test results. Two years of mentored collaborative learning in small student groups prepares the medical students for communicating collaboratively as interns within teams in the hospital.

## SUMMARY

Adequate concepts of communication for a CSCL pedagogy should:

- Focus on group interaction & collaborative learning.

- Conceptualize technological supports as communication media & knowledge artifacts.
- Account for interplay between individual, small group and community learning.
- Consider the larger social context and cultural situation.

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