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Communicating with Technology

When I finished the studies reproduced in part I, I felt a strong need to understand collaborative phenomena like negotiation as communicative interaction. I started to study under, work with and collaborate with people in the communication sciences. Together, we gradually conducted the analysis in chapter 12. Very recently, I hired a conversation analyst to work on the VMT project; he helped with the analysis in chapter 21. I have been increasingly impressed with the orientation of communication theory to group phenomena. For instance, my methodological recommendations in chapter 18 are squarely based on Garfinkel's ethnomethodology. In this chapter I review the spectrum of communication theories as they are relevant to this book.

The advent of global networking brings the promise of greatly expanded collaboration opportunities—both for learning together and for working together without geographic limitations. To realize this promise, we need to recognize the different nature of communication, learning and work in online settings of collaboration. This chapter looks at groupware as a medium for online communication and collaborative learning. It shows how these differ from traditional conceptions of communication and learning focused on individual cognition, and draws consequences for the design of CSCL and CSCW systems.

Groupware as Medium of Communication and Learning

Carefully designed groupware and corresponding social practices must be developed if we are to realize the potential of computer-supported small-group collaboration. At the core of this is an understanding of communication in online groups and how software can support the specific needs of this new form of interaction.

Collaboration can involve the building of group knowledge. In collaborative learning, the explicit goal is to build some knowledge that might answer an initial question posed by the group or provide group members with a deeper understanding of a topic they are studying. In cooperative work, the group generally must build knowledge needed to accomplish a task, if only knowledge about how to divide up and manage the work.

Learning, work and coordination in groups require communication. This is particularly apparent in online group activities, because the subtle forms of communication that we take for granted in face-to-face interaction—such as non-verbal expressions or gestures—must be replaced with explicit forms of communication in online situations.

Groupware to support online work and learning by small groups must function primarily as a communication medium. It must support the particular forms of communication needed in computer-mediated interaction where the participants are separated geographically, and possibly temporally as well. This form of communication has special requirements compared to face-to-face conversation and needs its own theory of communication.

This chapter starts by reviewing the received conceptions of communication and learning, and then contrasts them with the needs of online groups.

Traditional Theories of Communication

There are many general theories of communication. A standard textbook by Littlejohn (1999) lists nine broad categories of communication theories, which 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 present in groupware. Groupware—software designed to support group interaction and group work—of necessity combines technical, collaborative and learning issues, and does so in novel ways.

Groupware is often divided into CSCW and CSCL, with one typically focusing on workplaces and the other on schools (both presence and distance). This separation is justified by significant differences between these two social contexts. CSCL is different from CSCW because learning situations are different from work situations in several important ways. In a school context, there is generally a teacher who structures the goals and activities of the group in order to facilitate learning processes. The classroom culture is very different from workplace cultures—for instance, in terms of the social practices

and reward systems. Furthermore, members of collaborative learning groups are relative novices with respect to the topic being studied, whereas workers studied by CSCW researchers are experienced professionals.

Nevertheless, it is also true that both learning and working—broadly understood—centrally take place in both contexts. If one closely observes the interactions of online groups collaboratively working or learning, one sees that the workers engage in many learning tasks and the learners do work of various sorts. Many forms of contemporary work involve building knowledge and sharing it; students learning collaboratively often work hard at establishing divisions of labor; some tasks like negotiating decisions intimately combine working and learning. Because collaboration is a matter of constantly sharing what one knows and maintaining shared understanding, one can consider all collaboration to have the structure of collaborative learning.

The very phrase "collaborative learning" combines social and individual processes. The term "learning" is commonly 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 and communication 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 communication theory.
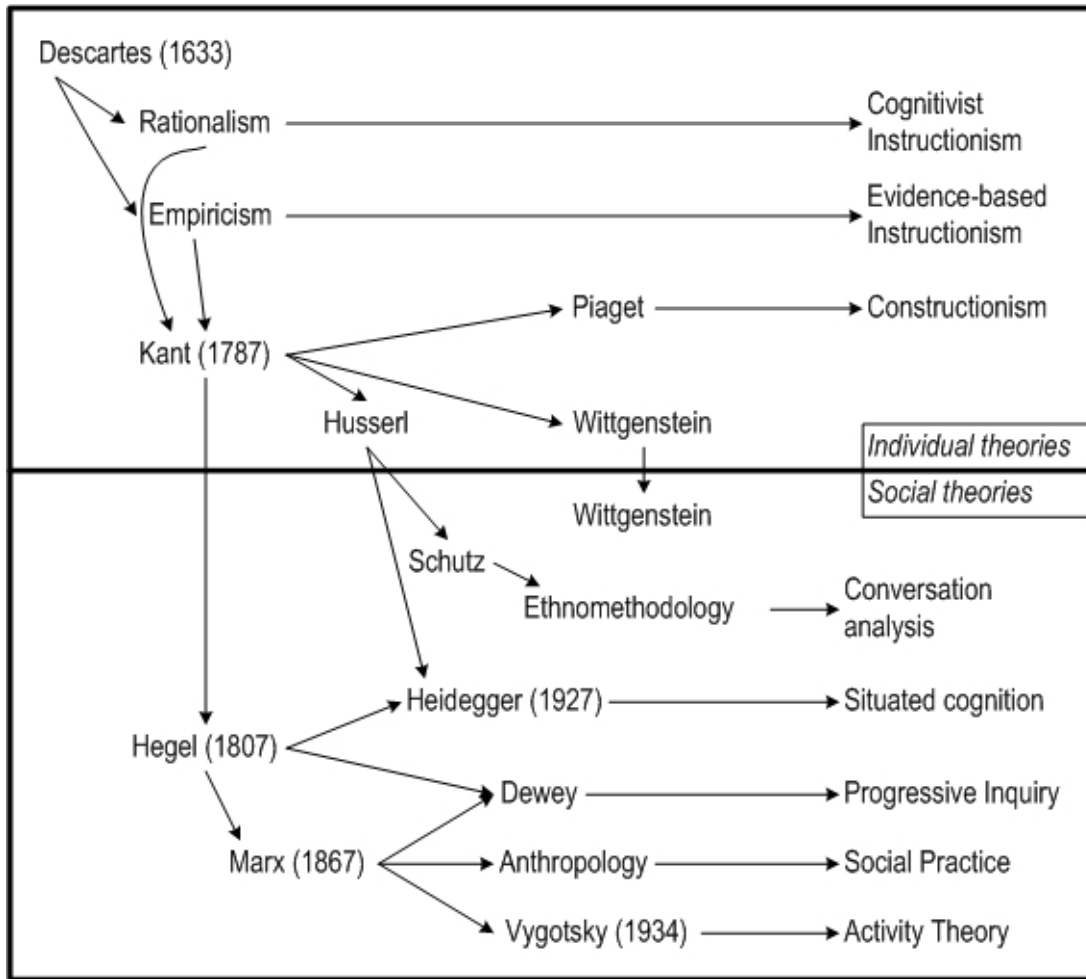
Figure 14-1. Influences on individual theories of learning (top of figure) and social theories of learning (below the line).

As diagrammed in figure 14-1, 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 theories that are now relevant to groupware, cooperative work and collaborative learning.

Figure 14-1 goes approximately here

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 (e.g., Johnson & Johnson, 1989). This was, of course, prior to interest in groupware support for online 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 learn 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). Under these themes, work, learning and social interactions come together inextricably.

With the rise 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 groupware communication environments would structure student contributions to online threaded discussions into knowledge-building processes of collaboration. Work became a model for learning, even as knowledge building became a way of life in workplaces.

The new learning 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. Vygotsky's followers further developed this social aspect of knowledge generation into activity theory , which emphasizes 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 work and learning is complex. Groupware cannot be designed to support a simple model of communication and learning, but must take into account interactions among many people, mediated by various artifacts, and pursuing pedagogical goals at both the individual and group unit.

The software itself can be conceptualized as a mediating artifact of collaborative communication and situated cognition: the technology introduces physical constraints as well as sophisticated symbolisms (e.g., technical terms, icons and representations of

procedures like Web links). This means that students and workers must learn how to use the groupware artifacts and that the technology must be carefully integrated into pedagogical and work activities. Researchers trying to understand how to design classroom pedagogies, workplace practices, 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.

Communication Using Groupware

The circumstances of computer-supported collaborative work and 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, groupware simultaneously transforms the mode, medium, unit and context of communication.

The mode of groupware communication. Groupware 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 is needed to take advantage of the affordances of each.

The medium of groupware 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 groupware 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 groupware communication. Collaborative learning or working often focuses on the small group of perhaps four or five participants. Groups work and learn by engaging in activities like brainstorming, sharing information, reacting to each other's

utterances, discussing, negotiating decisions and reaching common conclusions. The group may learn 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 with which no member will leave. 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 or department, a school or corporation, a society or economy. 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 groupware communication. Group communication takes place primarily through discourse. Discourse is a sequence of utterances or brief 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 observing 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, and culturally situated.

Empirical Analysis of Collaborative Communication and Learning

The complexity of communication in groupware implies that empirical assessment of collaborative accomplishments should take place on the individual, group and community levels of analysis, and should show how these levels interact. Here are some common approaches:

Individual outcomes. Perhaps the most oft-used approach for assessing collaborative learning 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 such as collaborative and individual, or computer-mediated and 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, as thread statistics will be very dependent upon factors like teacher or management expectations and reward 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 a group process. Of course, it cannot follow the development of a group idea in detail.

Conversation 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, etc. These structures are quite different in computer-mediated modes of communication compared to face-to-face situations, which have been most analyzed. Despite its difficulty, this method of empirical analysis can be pursued when one wants 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 spoken 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.

Technological Support of Groups

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

Integrated design. Collaborative software must not only allow people to share documents, diagrams, etc. They should also allow the collaborators to discuss these artifacts together. For instance, users should be able to annotate segments of text or pictures or even other annotations, thereby potentially constructing threaded discussions of the shared materials.

Shared meaningful media. Both the computer support media and the curricular content materials they convey are meaningful artifacts. They embody meanings that group members must learn and come to share. Collaborators can only use a software artifact or the documents stored in it if they can make sense of the documents and of the technology, as it was designed. Furthermore, this sense must be constructed collaboratively if it is to work for the group. The software must be designed in a way that permits or fosters this.

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. Participants should have a presence when communicating and should feel they are engaged in a social experience.

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.

Shared learning place. The starting point for a groupware environment is a shared repository and communication center, such as a virtual meeting place.

Pedagogy of Collaboration

The nature of CSCL communication suggests that curricula be structured much differently than 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, which is removed when the building

can stand on its own. The teacher functions mainly as a facilitator of learning, rather than as a primary source of factual domain 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 students (Barrows, 1994). Groups of students work with a mentor who is skilled in collaborative learning but who offers no medical information. During their course of study, students engage in a series of medical cases that have 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 in-depth 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.

Implications for Groupware Design

The design and evaluation of software to support online collaboration should take into account the special communication characteristics of online interaction as well as the principles of situated learning. Three recommendations for doing this are:

1. *Focus on Group Interaction and Collaborative Learning*. Learning—whether in a classroom or at a workplace—should be seen as an active process of knowledge construction by a group. A deep understanding of a topic is generally developed through critical debate among multiple perspectives, and is therefore an inherently social process even if it can be internalized in an individual's head. The development of knowledge content may be inextricably accompanied by the development of increased competence in cooperation, coordination and collaboration skills. Collaborative learning and cooperative work thereby merge into the model of increasing participation in communities of practice.

2. *Recognize the Interplay of Learning at the Unit of the Individual, Small Group and Community*. The classroom teacher or the workplace supervisor must initiate, structure and guide the group discussion, As leader, facilitator or moderator, a person in this role has responsibility for supporting and directing the knowledge-building process on both the individual and group levels, within the social context. A deep discussion of the content must take place along with the self-organization of the group in order to promote the goals of the larger community.

3. *Conceptualize the Software as a Communication Medium and a Knowledge Artifact*. A technical environment can offer various collaboration and communication facilities. These constrain how knowledge can be constructed, shared and preserved by the members of a group. The designers of an application, or the people who select and configure software for a particular occasion, must be careful to match the advantages of the different synchronous or asynchronous communication possibilities to the task, so that selected components integrate well with each other and compensate for each other's weaknesses. The software should not only be conceived of as a medium for group communication, but also as a working knowledge repository, in which important learning artifacts can be stored, related to each other and collaboratively refined. The software environment can itself be viewed as an artifact, whose meaning must be collaboratively interpreted and refined.

The Promise of Communicating with Technology

The nature of online groups holds the potential of enabling forms of collaboration more powerful than are possible in traditional face-to-face collaboration unmediated by technology. The technology (a) overcomes physical limitations, (b) provides computational support and (c) creates new modes of interaction. We can see this potential of collaboration in the realms of (i) communication, (ii) learning and (iii) work.

(i) The Promise of Collaborative Communication

(a) Collaboration depends upon the people who come together in a group. The "anytime, anywhere" nature of online, asynchronous communication allows groups to interact without regard for conflicting personal schedules, so that everyone who should be included can be included. One can participate in special interest groups that are so narrow that no one for miles around shares one's passion. More people can be included in groups, so that a group can draw the most appropriate participants from around the world. The foundations of the still-distant vision of a global village are gradually laid by the formation of small collaborative groups freed from the traditional constraints of family and neighborhood to mediate universally between the individual and humanity.

(b) The technology allows users to express themselves in a neutral, textual format that hides individual physical differences. It also allows users to retrieve and manipulate past messages, and to respond to them at will. The fact that one can express one's ideas leisurely, when they occur, even if other group members have moved on to other topics means that people who are hesitant or slower to express their thoughts have more opportunity. Physical disabilities and personal characteristics that restricted participation in the past—immobility, accents, shyness—play less of a role now.

(c) The characteristics of computer-mediated communication transform the mode of interaction. It takes the move from an oral to a literate culture further. Communication in a wired culture can be more reflective, although it is often the opposite. Communicated texts are persistent; they may be archived, annotated, cut-and-pasted, reconfigured. This increases their power to refer and link to other texts. However, the sheer increased volume of texts drives users to skim more quickly and ponder less frequently. We still lack the computational support to weed through the glut of information and present only that which truly requires and deserves our attention.

(ii) The Promise of Collaborative Learning

(a) Collaborative learning overcomes the limitations of the individual mind. When an individual builds knowledge, one idea leads to another by following mental associations of concepts. When this takes place in a group, the idea is expressed in sentences or utterances, with the concepts expressed in words or phrases. As suggested in chapter 13, the mental process can be understood as an internalization of more primary socio-linguistic processes. That is, meanings are built up in discourse—or in internalized dialogue—and then are interpreted from the individual perspectives of the group participants. Online collaborative learning allows more voices to chime in. By taking advantage of a persistent record of discourse, group knowledge building can pay more careful attention to the textual linkages interwoven in the texture of interactions, overcoming the rather severe limitations of human short-term memory for knowledge building.

(b) Computational support could further strengthen a group's ability to construct and refine their understanding or theories. Today's collaborative knowledge management tools are primitive, but already they allow groups to search the Web for information and to scan through their own online conversations. The structure of the Web itself permits hypertext linking of ideas, providing an alternative to linear presentations of text. More sophisticated and adaptive structures are possible by storing short units of text in a database and sorting or arranging them in completely different ways for various presentation occasions, as was done in `WebGuide` (chapter 6).

(c) Group learning has a qualitative advantage over individual learning. It is not just that two minds are quantitatively better than one, or that the whole has a Gestalt that exceeds the sum of its parts. The synergy of collaboration arises from the tension of different perspectives and interpretations. During discourse, a meaning is constructed at the unit of the group as utterances from different participants build on each other and achieve an evolving meaning. For successful collaboration, a high degree of shared understanding must be maintained among the participants. Spoken interaction has many subtle resources for supporting this, and computer-mediated communication must provide a comparable set of mechanisms. Actual discourse is filled with repair activities to re-establish shared understanding when interpretations become too divergent. But the small and ubiquitous divergences of understanding within small groups also have a powerful productive force, often hidden under the label of "synergy." An utterance is largely ambiguous in meaning until it is fixed by subsequent utterances into the emergent meaning of the discourse. The openness of an utterance to be taken differently by other utterances and to be interpreted variously by different discussants opens up a productive space for interpretive creativity. Combined with the diverse backgrounds and interests of

group members and by the complex characteristics of activity structures within which collaborative discourses take place in the raw, the connotations and references of utterances can be incredibly rich. Unanticipated new knowledge emerges naturally from effective situations of group collaboration to an extent that it could not from individual cogitations. In the literate world, new ideas are printed for public critique and refinement. In the wired world, discourses take place in online groups, whose situations and membership can take on virtually limitless forms, resulting in new modes of knowledge building.

(iii) The Promise of Collaborative Work

(a) In the information age, work centrally involves knowledge building. The extraordinarily developed division of intellectual labor means that many tasks are much more efficiently accomplished if people can be found who have just the right expertise. Of course, this is more likely if one can search the globe rather than simply looking for people in one building. By enormously increasing the choice of people to work together in an online group, one can then assign to each person just the tasks at which they are best. Of course, this entails new overhead tasks—bringing the right people together and managing the collaborative product—but in the long run, this should mean that individuals do not have to do so much tedious and routine work and can spend most of their effort doing what they do best. It should also dramatically reduce the total amount of work that has to be done as a result of efficiency increases. Unfortunately, we have yet to see such benefits because the socio-economic relations of work have not yet changed in response to these potential new forces of production.

(b) Collaborative work should be able to take advantage of the kinds of computer support that individual work has recently gained. So far, most software is designed with a model of work performed by individuals, or by sets of individuals who send messages back and forth. There is little software designed for groups, as such. Given the current state of technology, groups tend to take their assignment and break it down into tasks that individuals can do, and then send their individual contributions back and forth to combine them into a group product. What kind of group productivity software or collaboration environment would allow the group to work collaboratively, and what forms of computational support would facilitate this group work?

(c) The Web, supplemented by the myriad digital libraries now proliferating, provides access to the record of human knowledge. Almost. When one looks closely, one sees that there are still overwhelming barriers to making this a reality. The technology is virtually there. But much of the interesting human knowledge is being held back. In fact, the more valuable and sought after information is, the more tightly it is restricted from public access. This might be termed the contradiction of information access today. World leaders increasingly fan the flames of fear and prejudice to limit global collaboration; employment conditions restrict the sharing of expertise; vigorously defended legal structures prohibit free access to intellectual property, from pop music to academic writings. The ideology of the individual still holds back the promise of the group to benefit from the products of collaborative learning and work.

The task of realizing the promise of communication, learning and work in online groups sets an ambitious technical, social and political agenda for our times.