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## Building Collaborative Knowing

*This chapter discusses a core phenomenon for a theory of collaboration: meaning making, or the collaborative building of knowledge. Written before I started to use the term “group cognition,” it nevertheless focuses in on precisely that phenomenon. This was my attempt to draft a theory that discussed the most important aspects of group cognition, such as the relation of individual to group. At the same time, it reflects on the role of such a theory.*

*Rather than reviewing, one after another, various theories that are currently influential in the fields of CSCW and CSCL, a view of collaboration is outlined here that synthesizes important concepts and approaches from these other sources. It takes some of the abstract concepts proposed by these theories and illustrates them with the example of building collaborative knowing analyzed in chapter 12. It contributes to a social theory of collaboration by unpacking central concepts and by using them to understand the process by which a small group collaboratively builds new meaning. The better we understand how the processes involved in collaborative learning actually work, the better we can design computer support for them and the better we can evaluate the effectiveness of both the collaboration and the support.*

### 1. Elements of a social theory of collaboration

#### 1.1. The Need for a Theory of Collaboration

It is often assumed that every professional discipline is founded on a well-developed theory that defines the objects, goals and methods of its domain. However, when one really needs to use the theory—such as to guide the design of concrete software to support collaboration—one discovers that what exists, at best, are bitter controversies and disturbing questions concerning the fundamentals. This is certainly the case with CSCL: We are still arguing over its very name (Koschmann, 1996b).

Yet, one cannot proceed without theory. How would developers, teachers or researchers know what kind of software or curriculum to develop, how to introduce it into the classroom, or how to assess its effectiveness without at least an implicit theory of CSCL?

Definitions—a starting point for theory—are always contentious. What authors mean by “computer support,” “collaborative” or “learning” are different every time someone else tries to define them. (If one pragmatically says, just look at the papers at a CSCL conference to see what the domain is, one finds papers that never mention computers, let alone pedagogically innovative software, or that have nothing to do with collaboration and may be far removed from most concepts of learning.) Yet, despite this, there is a field of CSCL with an active research community and much to recommend its adoption.

This chapter will provide a consciously contentious perspective on key elements of theory for computer-supported collaboration. In particular, it will be contentious by

emphasizing activity and accomplishments at the *group level*. This is what we mean by a *social* theory of learning, in contrast to traditional ideas about learning as something that takes place primarily in the minds of individual people. Because the word “learning” often directs attention at psychological or mental processes at the level of the individual participant, this chapter will often use the term “building knowing” in place of “learning.” Rather than saying that a group learns, we will say it builds the extent or depth of its knowing. This slightly awkward locution has the added advantage of distancing itself from the idea of accumulating things called “knowledge,” as in the idea of “learning facts”; what groups learn are often practices, ways of doing things, rather than facts. Pea (1993b) similarly uses the term “distributed intelligence” to avoid the connotations of “learning” as involving de-contextualized mental representations of individuals.

## **1.2. A Core Phenomenon of Collaboration**

The term “building collaborative knowing,” coined for this chapter, is derived from the work of Scardamalia and Bereiter (1996), who did much to found the field of CSCL. As used here, the phrase is intended to point to a core process in collaboration: a particular way in which a group may construct a new degree of understanding about the topic that they are investigating. This new knowing is something that the group creates that cannot be attributed to the mental processes of any one individual. As Bereiter (2002) says,

The mark of a really successful design or problem-solving meeting is that something brilliant comes out of it that cannot be attributed to an individual or to a combination of individual contributions. It is an emergent, which means that if you look at a transcript of the meeting you can see the conceptual object taking shape but you cannot find it in the bits and pieces making up the discourse. There are, of course, instances where the design or solution does come from one person, but then you have a different kind of meeting, one that is devoted to grasping, accepting and elaborating an idea. The result is still a social product, no matter how much it may bear the stamp of an individual. (p. 283)

This emergent group phenomenon is of particular interest to a theory of collaboration. We hypothesize that the building of knowledge, understanding and meaning—learning, broadly speaking—within a group is central to the activity of both cooperative work and collaborative learning. Thus, it is a core phenomenon for the study of computer-supported small-group collaboration, including both CSCW and CSCL.

There are many ways in which “learning” can take place: over short and long time periods, in solitude and socially, formally and informally, tacitly and explicitly, in practice and in theory. There are many ways in which people collaborate and learn: by teaching each other, viewing from different perspectives, dividing tasks, pooling results, brainstorming, critiquing, negotiating, compromising and agreeing. While all these aspects of learning and collaboration may be relevant to CSCW and CSCL, we will focus on the phenomenon of building collaborative knowing, where group members together invent knowledge and skill that none of them would likely have constructed alone (Fischer & Granoo, 1995; Hatano & Inagaki, 1991; Mead, 1934/1962; Wittgenstein, 1953). We will look again at the transcript from chapters 12 and 13, where we saw

increased knowing taking shape in the group discourse, and where we noted that it was not attributable to individual understandings.

Collaboration takes place within other activities of learning and cooperation, such as individual meaning making and social enculturation. This chapter focuses on those brief, possibly rare episodes in which group discourse builds meanings, which can then be variously interpreted by the group members or sedimented in artifacts. It may well be in the mining of such gems of interaction that the potential of computer-supported collaboration lies. Too often, this key stage in collaboration is skipped over by theories; either it is treated as a mystery, as an individual act of creativity that is not further explained, or it is wrapped up in an abstract concept like “synergy,” which names the phenomenon without analyzing it. But this emphatically collaborative achievement is a key to comprehending collaboration, for this is what most dramatically sets it apart from individual learning. At least that is the hypothesis of this chapter. The analysis of such a group accomplishment requires a new way of thinking, a social theory.

### **1.3. A Social Theory of Collaboration**

It is not bad for theory to be subject to contending views and arguments, and to have to compete for acceptance. The purpose of proposing theory is to subject it to the discourse of the research community so that it can be refined, critiqued and negotiated to contribute to that community’s collaborative knowing. This is where science gets its real power (Donald, 1991). This book is not an attempt to expound a set of eternal truths, but an effort to engage in a collaborative process of building shared knowing about the field of computer-supported collaboration and its potential. This chapter pulls together threads from an on-going conversation and contributes a new, tentative, textual artifact into that process in the hope that it will be taken up, critiqued and modified.

The theories incorporated here are particularly contentious because theoreticians like Lave (1996) or Engeström (1999), for instance, build on a *social* theory tradition that goes back to Hegel (1807/1967), Marx (1867/1976) and Vygotsky (1930/1978). This theory is historically, culturally, linguistically and politically foreign to many people, whose intellectual instincts are shaped by an older, more ingrained tradition that focuses on *individual* minds as rational agents.

Prevalent enlightened thinking about learning owes much to Descartes’ (1633/1999) theory of ideas as existing in individual minds isolated from the material and social world. Thorndikian educational theories, which still dominate schooling, go back to this philosophic position. The history of philosophy and theory since Descartes has moved toward a more dynamic, social view. Kant (1787/1999) argued that our knowledge of reality was not simply given by the material world, but was constituted by the human mind, which imposes a basic structure. Hegel (1807/1967) introduced a developmental view in which this process of constitution evolves through historical changes. Marx (1867/1976) grounded these changes in socio-economic phenomena. Heidegger (1927/1996) then proposed a view of human being that is more firmly situated in the world than Descartes’ approach. Figure 14-1 in chapter 14 provided a graphical representation of how the influences mentioned here led to social versus individual theories of learning. We will develop this line of thought further, particularly in chapter 20.

#### 1.4. This Chapter's Approach to Theory

It is difficult for most people to think in terms of group cognition because of the traditional focus on the individual. It is also hard to comprehend the subtle and complex interactions that pass between group and individual knowing or between meaning embedded in an artifact and its interpretation in a person's mind. But such comprehension is necessary for understanding the social approach to a theory of collaboration.

One needs, first of all, the right vocabulary for thinking about phenomena that occur on levels of analysis that we are not familiar with discussing. We need appropriate conceptual resources and analytic perspectives. This is what is meant here by a "theory." Philosophy used to provide such intellectual tools, but recently this has become a task for interdisciplinary sciences, such as cognitive science, learning science, CSCW or CSCL, all of which build upon anthropology, communication theory, social theory and computer science. This chapter will draw on theoretical reflections and conceptualizations from these fields to try to understand the phenomenon of building collaborative knowing. "Theory" in this chapter is not meant in the sense of clear and distinct definitions of concepts, empirical laws, rigorous methodologies and mathematical precision. It is meant to provide a way of looking at social interactions in terms of inter-related phenomena and concepts such as: "artifact," "situation," "meaning," "interpretation," "tacit knowing," "perspectives," "negotiation" and "internalization." These concepts are not so much defined in unambiguous sentences, as they are borrowed from other theories or philosophies and adapted into an emerging conceptualization. The terms glean their definitions from each other as a result of how they are configured together (Adorno, 1958). Hence, these terms should become gradually more meaningful as one reads through the chapter and tries to apply its view to the phenomena presented or to one's own world.

The nature of the interactions involved in building collaborative knowing have scarcely been investigated in any tradition, although they are absolutely fundamental to a possible theory of collaboration. While available philosophies can provide some direction for exploring these interactions, empirical investigations are urgently required. We need to better understand how knowledge and meaning can be encapsulated in a wide variety of artifacts, and then how groups of people can come to understand these embedded meanings and effectively interpret them. We need to look carefully at examples of this taking place under real-world conditions. Therefore, this chapter will begin with a review of chapter 12 and 13's empirical analyses of an instance of collaboration (see section 2 of this chapter).

The empirical example introduces the intertwining of individual (psychological) and group (social) processes (section 3 of this chapter), through which collaborative knowing can be built. The sharing of knowledge among group participants as well as the building of the group's own knowing is accomplished interactively, primarily through situated discourse processes (section 4 of this chapter).

Discourse, which makes things explicit, relies on a background of tacit or practical knowing; the co-construction of shared knowing in discourse involves the negotiation of tacit meanings, for instance of the affordances of artifacts (section 5 of this chapter). The network of these meanings constitutes the social world in which we live, and which we come to understand by building collaborative knowing (section 6 of this chapter).

This chapter attempts to suggest the core elements of a social philosophy that could provide a foundation for CSCW and CSCL. Such a theory necessarily involves issues of epistemology, semiotics, hermeneutics and ontology. *Epistemology* asks how knowledge is possible; social epistemology shows how knowing is interactively constructed within communities (section 3). *Semiotics* asks how signs can have meaning; social semiotics shows how meanings of signs and other artifacts are socially constituted (section 4). *Hermeneutics* asks how we can interpret meaning; social hermeneutics shows how individuals interpret socially shared meaning (section 5). *Ontology* asks what kinds of beings exist; social ontology shows how beings are produced and reproduced within a society (section 6).

The kind of social epistemology, semiotics, hermeneutics and ontology proposed here would not provide a complete social theory. For that, we would have to build up from the social as small group to the social as institutions and multi-nationals, including cultural and historical levels of description—and then return from these abstract social formations to the concrete activities in which people find themselves in any given moment, but this time fully mediated by categories and understandings from the larger socio-historical context (Bourdieu, 1972/1995; Giddens, 1984b; Habermas, 1981/1984; Marx, 1867/1976; Sartre, 1968). The foundations and concepts for such a full social theory could come in part from the elements presented in this chapter.

## **2. A Moment of Collaboration**

The theory presented in this chapter emerged through an analysis of the specific example of collaborative learning discussed in chapters 12 and 13. This section reviews that example. The following sections then use the example to illustrate the concepts of the theory.

### **2.1. Why We Need Empirical Examples of Collaboration**

Writing about contentious matters like the nature and mechanisms of collaboration is risky. Each reader will interpret the meaning of what is said by relating it to her own experiences or to his existing understandings and to prevalent “folk theories” (established wisdom and common worldviews). Paradigmatic examples of small groups building collaborative knowing are still rare these days and the mechanisms underlying them have yet to be well analyzed. So, skepticism and misunderstanding are the expected outcome unless the starting point for the reader’s interpretation can be appropriately grounded in shared experience. To this end, we first review the empirical example and some hints for interpreting it. I invite the reader to study the analyses in chapters 12 and 13, and to search for and reflect upon other examples (such as Koschmann, 1999b; Roschelle, 1996; Sfard & McClain, 2003) and studies from ethnography, psychology and ethnomethodology.

Clearly, this case study is not representative of all collaborative activities. However, it provides a particularly useful illustration of the phenomenon of building collaborative knowing, which we want to analyze in this chapter. That our example represents some generality is suggested by its similarity to what Hatano and Inagaki (1991) describe as “collective comprehension activities” in Japanese classrooms: they take place among

small groups of students, involve references to an artifact (or source of confirmation) and include room for comprehension.

The example we present takes place in a middle school, not in the world of work or higher education. This provides a clear view of the collaborative building of an instance of elementary science knowing: the principle of varying only one parameter of an experimental situation at a time. In a higher education science class or a professional scientific laboratory, most people would have some sense of this principle, but in middle school we can observe such an understanding still under construction. In addition, the discourse is not computer mediated; the face-to-face interaction provides richer, clearer, more intuitive evidence for what is taking place. This is helpful for analyzing the detailed interactions that constitute the building of collaborative knowing, although examples will also need to be studied where the communication is computer-mediated (see chapter 21). The sample interaction is, however, computer-supported by a software rocket simulation, so that we can observe how the students increase their knowing about how to use a digital artifact.

Empirical examples are more than mere aids to presentation of a theory. It is necessary to show how theory is grounded in and integrated with empirical studies. Theory can be very abstract and leave the detailed mechanisms undeveloped. Often, these details are crucial for practical application of the theory—such as for guiding the design of technology to support collaboration—and are required for fleshing out the theory itself. Thus, while several recent theories stress the role of artifacts as embodiments of shared understanding (e.g., Dourish, 2001), little has been written about how new users of the artifacts learn to share these stored understandings—a question investigated in a modest way in our example (especially in chapter 13).

The empirical example used in this chapter is not an arbitrary illustration of theoretical ideas that are unrelated to it. The theory in this chapter actually grew out of chapter 12's detailed analysis of this particular collaborative interaction. By presenting the theory within the context of its empirical origin, we try to situate the reader within a concrete understanding of the phenomena being analyzed.

## **2.2. The Experimental Situation**

Recall from chapter 12 that five 11-year-old boys were experimenting with a computer simulation of model rockets with different design attributes (different engines, nose cones, fins and surface textures). The students could fire 8 different rockets and record their heights in a datasheet. A list of the attributes of the 8 rockets was displayed on the computer screen next to the simulation (see figure 12-1 in chapter 12). Two sessions with the simulation totaled 3 hours and were video-recorded.

The first session began with the students reading the list of rocket descriptions and discussing with the teacher how to figure out which attributes did best in the simulation. Then, working in two subgroups, they fired the different rockets multiple times and averaged their heights to adjust for random fluctuations due to simulated weather conditions. After filling in their data sheets, the students were guided by the teacher to figure out which attributes were optimal. Most of the discussion up to this point had been teacher-centric, with the teacher posing questions, evaluating responses and controlling turn-taking, as is typical in school settings (Lemke, 1990).

A key aspect of the experiment is that the list of rocket descriptions was carefully designed to make it easy to compare pairs of rocket descriptions that differed in only one attribute. The relevant pairs were listed consecutively and the differing attribute was written in bold face. However, even after having read the list aloud and having worked with the simulation for over an hour—with the list on-screen the whole time—the students were literally unable to see this property of the list.

### 2.3. Preliminary Analysis

At a certain point, after the teacher gestured at the list, the students launched into intense collaborative interaction, which consisted of a brief utterance about once every second. What follows is a transcript of that collaborative moment, beginning with the teacher’s directing of the group attention to the list. We can review our analysis from chapter 12 by dividing the interaction in the transcript excerpt into four phases:

*Phase a.* The transcript begins at 1:21:53 with the teacher posing a rhetorical question, which was then clarified at 1:21:59 as asking the students to find a pair of rockets on the list that had the same engine but different nose cones. The students responded that there was no such pair in the list. This was not the expected response to a rhetorical question, and indicated a breakdown in the group discourse.

1:21:53	Teacher	And (0.1) you don’t have anything like that there?
1:21:54		(2.0 second pause)
1:21:56	Steven	I don’t think so
1:21:57	Jamie	Not with the same engine
1:21:58	Steven	No
1:21:58	Jamie	Not with the same
1:21:59	Teacher	With the same engine ... but with a different (0.1) ... nose cone?
1:22:01	Chuck	the same
1:22:01	Jamie	Yeah,
1:22:02	Chuck	These are both (0.8) the same thing
1:22:03		(1.0)

*Phase b.* After a significant pause at 1:22:03, Brent excitedly pointed to what the teacher had asked for: a pair of rockets with a nose cone difference. Brent lurched forward and physically gestured at the list, forcibly directing the group attention there. This altered the structure of the group. In *phase a*, the students were united against the teacher; in *phase b* Brent joined the teacher; in *phase c* other students successively aligned with Brent and the teacher; finally, in *phase d*, a new consensus was established.

1:22:04	Teacher	Awright
1:22:05	Brent	This one’s different ((gestures with pen at computer 1 screen))
1:22:06	Jamie	Yeah, but it has same no... (1.0)
1:22:08	Chuck	Pointy nose cone

*Phase c.* While Chuck continued to argue against the implication of the teacher’s rhetorical question, Steven, Jamie and Brent successively disputed Chuck’s utterances. They pointed to rockets 1 and 2 as being a pair with different nose cones.

1:22:09	Steven	Oh, yeah
1:22:10	Chuck	But it's not the same engine
1:22:11	Jamie	Yeah, it is,
1:22:12	Brent	Yes it is,
1:22:13	Jamie	Compare two n one
1:22:13	Brent	Number two
1:22:14	Chuck	(0.2) I know.

*Phase d.* Making explicit which rockets to look at on the list finally got Chuck to align with the rest of the group. Chuck had apparently been trying to find a rocket to compare with rocket 3 or 4 and had rejected 2 because although it had a different nose cone it did not have the same engine as 3 or 4. Once everyone saw the pair of 1 and 2, the group could proceed with their task and quickly draw a scientific conclusion.

1:22:15	Jamie	(0.2) Are the same
1:22:16	Chuck	Oh
1:22:17	Brent	It's the same engine.
1:22:18	Jamie	So if you compare two n one,
1:22:19	Chuck	Oh yeah, I see, I see, I see
1:22:21	Jamie	(0.8) Yeah. Compare two n one. So that the rounded n- (0.1) no the rounded one is better. Number one.

Keep this concrete interaction in mind when the discussions become more abstract in the following sections. In each phase we can observe phenomena that will be taken up in later sections.

In *phase a* there was a breakdown in understanding between the teacher and the students. In overcoming this breakdown, the group built collaborative knowing: by the end, the whole group knew how to find significant pairs of rockets on the list. Section 3 will look at how such knowing is interactively constructed in groups so that it is then available to the group's members.

In *phase b* and throughout the collaborative moment, we observed very brief utterances, like "This one's different," "The same" or even "Yeah." Such utterances are not meaningful by themselves, but only within the context of the group interaction. They serve mainly to point to other utterances, to reference items in the list or to engage in the group interaction (e.g., aligning, disagreeing, arguing or clarifying). Section 4 will explore how meaning—that was not completely present in these utterances of individuals—can be understood only at the group unit of analysis.

In *phase c* there was a concerted effort to realign the shared understanding of the group that broke down in *phase a*. At first, the students argued against the teacher. But in subsequent phases, they gradually came to align with him. In the discourse itself (and nowhere else), we could see these shifts as the individual interpretive perspectives of the different students changed and aligned. Section 5 will distinguish "meaning"—which exists in the shared social world—and "interpretation" of that meaning by groups and individuals; chapter 16 will discuss this distinction further.

In *phase d* everyone was able to see the descriptions of rockets 1 and 2 in the way implied by the teacher. Although the descriptions were in the list all along—and Chuck had even read them aloud an hour and a half earlier—it took a while for the students to see the meaning that had been designed into the artifact. Section 6 will explore how affordances and meanings that are preserved in artifacts and words must be interpreted



within concrete and practical situations involving discourse, tasks and other forms of interaction.

### **3. Individual and Group Knowing**

Theories of learning and collaboration tend to emphasize either individual or group knowing. It is difficult but important to understand how both take place and influence (or constitute) each other.

#### **3.1. Individual and Group Learning in the Example**

Our data about collaborative learning in section 2 is given at the level of a videotaped interaction and transcribed discourse, with some contextual information. To understand the learning that took place, a researcher must analyze it within the context of the small group. That is, the activity system of tasks, artifacts, interactions, symbols, social practices and roles within the community of practice forms the unit of analysis. It is in this unit that meaning is constructed and new ways of knowing are built. The meanings generated within this unit are absorbed into the group's knowing.

As researchers, we can analyze our data either by looking at the group discourse as a whole, or by following the trajectories of individuals within the group discourse. That is, we can focus either on the small group (i.e., the activity system as distributed among several people engaged with each other and with artifacts in complex ways) or on the individual as the unit of our analysis. Of course, we can also reflect upon how events at one level affect those at the other; this is, in fact, essential in order to get a full picture (Fischer & Granoo, 1995; Hatano & Inagaki, 1991). In our example data we saw that there is a breakdown in the group discourse and that individual contributors shift their positions within the group in order to re-establish a healthy group discourse.

#### **3.2. Shared and Personal Knowing**

We can also note in our sample transcript that individual utterances only make sense within the group context and the shared situation. Closer analysis—presented in section 4—reveals that individual contributions build on what has taken place within the group discourse, on current features in the shared situation and on future possibilities for joint activity. Thus, the individual utterances rely heavily upon the group discourse; we can argue that the group unit of analysis has an epistemological priority in that it provides prior conditions necessary for the knowing that can then take place at the individual unit.

The group unit is particularly significant in *collaborative* learning. In cooperative or coordinated work (as contrasted to collaborative), tasks are often divided up so that individuals actually work and build knowledge on an individual basis and then attempt to share the results. However, in collaboration, by definition (Dillenbourg, 1999), the work is done by the group as a whole. For this reason, social approaches to theory are especially appropriate for understanding collaboration. Section 4 will situate individual utterances and personal knowing within their social context.

### 3.3. Cognitive and Social Theories

Analyses of learning usually focus either on individual contributions as expressions of psychological states of individual people (the “cognitivist” or “acquisition” perspective) or on the collective accomplishments of a community or a society (the “socio-cultural” or “participation” perspective) (see Sfard, 1998). The cognitivist perspective takes utterances to be expressions of pre-existing mental representations or ideas of individuals, while the socio-cultural perspective takes elements of the language used to be social creations or accepted conventions of the culture. By analyzing our transcript data, however, we can see how both the utterances and the terminology they include are interactively constructed in the discourse as a whole—so that there is no need to posit either pre-existing mental constructs or fixed structures of social conventions independent of the discourse and causally determining it. Rather, on the contrary, we can see the mental and the social as results or products of previous discourse, now sedimented into meaningful cognitive and linguistic artifacts that function in current activities. Section 5 will discuss in more detail how meaning is thereby constructed and interpreted in small group interaction.

### 3.4. Collaborative Learning as Building Knowing

Collaborative learning can be viewed as the gradual construction and accumulation of increasingly refined and complex cognitive and linguistic artifacts. This takes place primarily in collaborative interaction. Secondly, these products of group collaboration and discourse can be internalized as the internal speech or thought of individuals. The cognitive and linguistic artifacts that develop are tools for knowing. As collaborative learning takes place, both the group in its interactions and the individuals who adopt and internalize these tools build their ability to know the kinds of things in which the group is involved. In our sample data, the group comes to know how to use the list of rockets as an artifact or tool to accomplish their activity. Section 6 will take a closer look at group mechanisms for building collaborative knowing and for individuals to understand and internalize what their groups and culture have built.

## 4. Situated Discourse

Utterances in our experimental data derive their meaning from the discourse situation, which they in turn contribute to interactively constructing.

### 4.1. References to the Situation

The utterances in our example transcript can be characterized as indexical, elliptical and projective. That is, they are not meaningful in isolation—the way propositions are traditionally taken to be. They are meaningful only through their references to the current physical context, prior utterances or projected future possibilities within the activity.

Looking at the utterances in our transcript, we can identify some that are *indexical*: their meaning depends upon their reference to some artifact in the environment, like a rocket or a rocket description (e.g., “this one ...”). Other utterances are *elliptical* in that

they leave out crucial parts of what would be a complete proposition, assuming that the hearer can fill these in based on previous statements in the discourse history (e.g., “Number two”). Finally, some utterances are *projective*: they must be interpreted in terms of a desired future state of the discourse (e.g., “So if you compare ...”).

The meaning of these utterances is not self-contained, but is constituted by reference to a totality of inter-connected artifacts that make up the world of the group. We call this world the *situation* and refer to the discourse as “situated.” Utterances often function as signs, pointing into networks of meaningful terms, artifacts and activities.

## 4.2. Preserving Knowing in Words and Artifacts

In our example situation, the word “different” plays an important role. In the pivotal utterance, “This one’s different,” there is an indexical reference to an item on the list artifact as well as to the teacher’s previous use of the term “different.” Brent appropriates the teacher’s term; in the subsequent group discourse, this reference is extensively developed in terms of what is or is not the “same” and the activity of comparing rockets. Over the course of the transcribed interaction, the participants gradually come to see what Brent referred to as “this one” as “different.” The vocabulary of “different,” “same” and “compare” serves to point out relationships in the list so that everyone in the group can see them. In the process, the terms preserve this new knowing-how-to-look-at-the-list in their extended meaningfulness to the group. At the end of the collaborative moment, the group knows much better how to use both the terms and the list artifact to which they refer. It is likely that the teacher already interpreted the terms and the artifact this way, but that the students had to learn to interpret these meanings as preserved in the terms and artifact.

Brent’s interpretation of “this one” as “different” is a first step in articulating a full meaning for the salient differences and similarities among pairs of rockets in the group activity. One can see here the initial phase of the verbal formation of meaning. It is like observing Michelangelo starting to chisel a rectangular block of marble and seeing a human form struggling to emerge from the inert stone in which it is embodied (figure 15-1). Brent may first use the term “different” by mimicking the teacher’s speech. As he and his fellow students continue to use it, its meaning becomes more differentiated, articulated and refined through its connections among more utterances and their circumstances. Eventually, we can say that the students have learned the meaning of the comparison vocabulary as scientific technical terms.

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Figure 15-1 goes approximately here

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In the next sections, we will describe how meaning is embodied in artifacts and sedimented in language. Through this, meanings that may have originally been created in ephemeral spoken utterances become *persistent*. This makes possible the preservation of the meanings over time, so that we can say that knowledge has been created as a product that can be effective over time.

### 4.3. Common Ground and Distributed Cognition

We have seen that meaning is given by a shared world that is interactively constructed in collaborative discourse. This is somewhat different from some understandings of common ground that start with individual units of analysis and then try to account for a shared reality (see chapter 17). Common ground is sometimes taken to be an agreement among individuals who all somehow have the same meanings or knowledge as part of their background understanding, and that makes possible further interaction (Clark & Brennan, 1991). But in our theory, as we have started to see and as we will see in more detail in the next section, the meanings are part of a single world, situation or activity system in which the individuals all interact. The common ground exists from the start for them as a shared world in which they exist together, and is not something that has to be established through some kind of agreement or coordination among mental contents.

This theory is not exactly the same as distributed cognition, which also argues that at least some meaning is “in the world” rather than all being “in people’s heads” (Hutchins, 1996). Certainly, meaningful artifacts exist in the physical world. But their meaning is not physically present in the world in the same sense as the body of the artifact itself. The meaning comes from the networks of reference in which the artifact is located (see chapter 16).

An artifact is perceived as meaningful, but this perception is a matter of interpretation. In our example, for instance, we saw that the meaning of the list artifact was not immediately perceptible to the students, but they had to learn how to see it. The common ground, which had broken down, was interactively achieved during and through the transcribed interaction; it was an accomplishment of the group interaction and not a matter of arbitrary agreement among the individuals of pre-existing ideas in their heads. The group discourse had to focus on the list as a salient artifact and explicate an interpretation of its meaning. The ability to include the list artifact effectively in their activity was something that the group had to achieve.



Figure 15-1. *Slaves: Atlas*. Michelangelo Buonarroti. c. 1530. Marble. Galleria dell'Accademia, Florence. Photo: G. Stahl, 2002.

#### **4.4. Creating Knowing at the Small-Group Unit of Analysis**

Knowing how to use the list artifact was not something that was passed from the teacher to the individual students through propositional instruction. Rather, the group of students evolved that ability by responding to each other's utterances. The teacher had established a context in which this could productively take place by setting up the classroom activity system with designed artifacts, specific activities that required knowing how to use the artifacts, and a pointed question that offered some terminology. The utterances at the start of the transcript disagree with each other ("No. . . . Not with the same. . . ."). Subsequent utterances respond to these, increasingly clarifying differences and justifying views. In the end, there is agreement within the group discourse, established by a process that took place within the group as the actor, subject or unit of analysis.

Collaborative learning took place as the group increased its ability to talk about the list artifact within the immediate task of responding to the teacher's hypothetical question and within the larger classroom activity of designing effective model rockets. Progress was made through normal discourse processes, specifically repairing a breakdown in shared references to rockets in the list. Overcoming the breakdown involved aligning the interpretations of the individual students with the meanings embodied in the list.

Theories influential within CSCL emphasize assessing learning on the community level and supporting community processes with technology: Scardamalia and Bereiter's (1996) vision of computer-supported learning communities, in which the community as a whole learns, was defining of the field. Lave and Wenger's (1991) situated learning involves changes in the social practices and configuration of the community itself. Engeström's (1999) expansive learning approach even looks at learning taking place when multiple communities interact with each other. In our example, we see an instance of learning unfolding through the communicative interaction of a small group. Here, the discourse is situated not only within a classroom community, but more specifically within the activity of the small group (see chapter 21).

### **5. Meaning and Interpretation**

Collaboration is a process of constructing meaning. Meaning creation most often takes place and can be observed at the small-group unit of analysis. Meaning in the context of collaboration is viewed as an integral part of communication, and therefore necessarily as shared within a community. Meaning can be embodied in physical or virtual (computer-based) artifacts or sedimented in words or gestures. Created by groups, institutionalized in communities of practice and preserved in artifacts, meaning must be reactivated by newcomers to the community as part of their apprenticeship (Lave & Wenger, 1991). Individuals must learn to interpret these meanings, as the students in our transcript learn to interpret the meaning in the list artifact and the meaning in the teacher's use of the term "different."

## 5.1. Meaning as Use and Knowing in Use

The kind of empirically based social theory we are proposing here looks at how groups actually create, share, use and interpret meaning as an integral part of social interaction. This is quite different from the mainstream tradition. Philosophers have long struggled to understand the nature of meaning by focusing on the individual unit of analysis. They sought the meaning of words in clear and distinct definitions, the meaning of ideas in their correspondence with reality or the meaning of thoughts in mental representations.

But these attempts to define meaning as a property of individual minds—whose mental representations correspond to realities in the world—did not succeed. In critiquing this tradition, Wittgenstein (1953) argued that the meaning of an utterance involved how it is used to accomplish practical moves within “language games” that are part of the speaker’s “form of life.” Austin (1952) and Searle (1969) further developed this view of speech acts as having pragmatic effects within group interaction systems, including social institutions and conventional practices. Functional grammar (Halliday, 1985) took this yet another step, analyzing the grammatical components of a sentence as relationships within a network of meaning.

Using functional grammar as a tool, Lemke (1990), for instance, analyzes the discourse of a science classroom as the construction of a complex network of meaning; this linguistic network constitutes the scientific theory that the students are learning. The collaborative learning of the class consists of the explicit elaboration of this network, and the individual learning of the students consists of their ability to re-state parts of this meaningful network. In constructing the network, the teacher and textbooks use a variety of alternative terms and metaphors, so that meanings can be abstracted from the use of multiple phrasings. Students are then expected to be able to talk, write and reason about parts of the network of meaning in their own words and to understand novel descriptions.

In our sample data, we saw a temporary breakdown in the construction of a network of meaning. Although the students had previously identified rockets with “different” fins, they could not abstract this ability to identify rockets with different nose cones under their specific circumstances. To overcome the breakdown, the students employed gestures, argumentation, peer pressure, the list artifact, clarification and explication. They also built on their practical experience with their model rockets, the simulation rockets and their data collection sheets. Perhaps most significantly, their success in constructing a network of meaning that included consistent references between utterances and rockets on the list artifact came about through group interactions driven by the classroom activity system, including the need to respond appropriately to the teacher’s hypothetical question. Thus, the network of meaning grew out of group discourse processes, but these were embedded in contexts of practical social activity. The knowing that the students built was not just a theoretical knowing evidenced by their ability to talk about the rockets consistently, but a practical knowing involving the ability to accomplish tasks within the activity structure context.

## 5.2. Tacit and Practical Knowing

It is common to think of “knowing” as the ability to state facts in propositions. But there is also what Polanyi (1962; 1966) calls *tacit knowledge*, which includes the ability

to *do* things—like ride a bicycle—even though one may not be able to put that knowledge into words. “Tacit” means “un-stated” and “explicit” means “stated in words.” The students know how to follow non-verbal communication cues like gaze, pauses and body orientation, as well as to engage in explicit discussion.

Heidegger (1927/1996) showed that tacit or practical knowing actually has an epistemological priority over explicit or theoretical knowing. To understand a proposition requires that one already have immense amounts of background ontological knowing about the world, about people and about the kinds of objects referred to by the proposition. Language is a form of communication and interaction with other people and with the world—to understand language one must understand it within the context of a broader tacit pre-understanding of social interaction and of the everyday world of ordinary life.

### **5.3. Interpretation as Making Explicit**

In the process of building collaborative knowing, there is interplay between tacit and explicit knowing. In Polanyi’s analysis, what is explicit is the current focus of attention. It stands forward against a background of tacit knowing. As attention shifts—e.g., as the topic of discourse moves on—what was explicit becomes tacit and something tacit is made explicit by being put into words. Heidegger calls the process of making explicit “*interpretation*” (see chapter 4).

Interpretation is making an implicit idea, *x*, explicit *as y*. By doing so, it integrates *x* into the situational matrix (as *y*). *X* is understood as having the meaning *y*, which is defined by *y*’s position in the interpreter’s network of references. Discourse is interpretation. It makes things “explicit,” or puts them into words. As man-made embodiments of meaning, words are semiotic artifacts that are part of the network of significations.

When Brent says, “This one’s different,” he is making explicit what he sees in the list artifact: he points to rocket 2 as different (tacitly, his implication is that rocket 2 is different from rocket 1 in terms of its type of nose cone). According to Heidegger, perception of the world and engagement in the world are always interpretive, even when they are tacit. The process of explicit interpretation takes the existing interpretation and develops it further. At first, Brent and the other students saw rocket 2 as not being comparable with rocket 3 or 4 because it had a different kind of engine. But then he suddenly saw rocket 2 as comparable, but different, from rocket 1. This became explicit as he saw the description of rocket 2 differently, leaned forward, pointed to it and said, “This one’s different.” Chapter 13 showed how the group and each of its members shifted from seeing the list as standard configurations to seeing it as paired configurations.

Brent’s “Aha! experience” is an instance of what Wittgenstein (1953) calls “seeing as.” Among several ambiguous graphical images, Wittgenstein presents a wire-frame cube (see figure 15-2). The viewer might first see a cube with its shaded end facing down to the right; then suddenly it appears as a cube with its shaded end facing up to the left. One can see the drawing as one cube or the other, or even as a set of lines on a flat surface—but one always sees it *as* something. It is not that there is first an un-interpreted grid of pixels (sense data) that someone subsequently interprets as one of the cubes. Rather, the perception of the image is always given as meaningful and tacitly interpreted.

Then it can be either re-interpreted or the interpretation can be explicated: put into words, made a focus of attention and further elaborated.

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Figure 15-2 goes approximately here

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#### 5.4. Interpretive Perspectives

Meaning and interpretation are always intertwined. Artifacts and utterances are immediately perceived as being meaningful. They are, from the start, perceived within a certain interpretation—however vague or confused. The interpretation may be made explicit and further elaborated—but it must always be grounded in the given meaning of the artifact or utterance within its context. For the purposes of this chapter’s theory we make a somewhat arbitrary and potentially contentious distinction between meaning and interpretation. We say that the *meaning* is defined for the community involved in the given situation and that the individuals each develop their own *interpretation* of that meaning. (This distinction will be worked out in more detail in chapter 16).

How do students learn? In our sample data we see how the students learn the meaning embedded in the list artifact through their collaborative interpretive processes. They make explicit the features of the list to each other by interpreting it (as “different”) and stating references (“compare two and one”).

As researchers studying classroom data, we can develop an explicit interpretation of the group meaning by analyzing the network of relationships constructed by the group discourse, taking the group as a whole as our unit of analysis. We call this network the *situation*. Every artifact, action, word or utterance obtains its *group meaning* from its position within this interactive situation.

Alternatively, as researchers we can develop an explicit interpretation of a specific individual participant’s interpretation by analyzing the behavior and utterances observed in that individual’s trajectory within the group interaction, taking that individual as our unit of analysis. We call this individual trajectory the *interpretive perspective* of that person. We say that the person interprets the group meanings from that perspective.

Roughly stated, meaning exists in the world, determined by the situation, and participants interpret that meaning individually from their personal perspectives. Of course, both the situation and the perspectives are constructed interactively and may be constantly evolving and interacting with each other. As we shall see in section 6, meanings may be embodied in artifacts and sedimented in language, but they were originally constructed through interpretive processes and their significance must be re-constructed by new participants who build knowledge with them in the future.

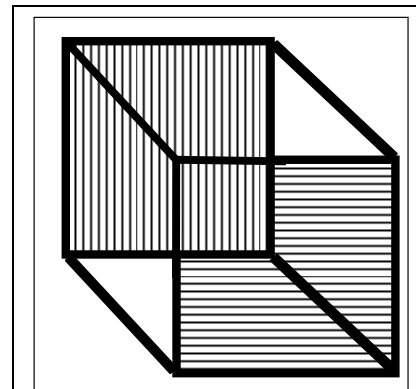


Figure 15-2. Diagram of a cube. First focus on the horizontal stripes as foremost, then on the vertical. Adapted from (Wittgenstein, 1953, §177).



It is not so much that meaning is “in the world” like a separate set of objects, but that things in the world always appear as meaningful. The students saw the list of rockets as meaningful from the start; to them, it was obviously a designed object with human meaning embedded in its form and its content. Brent understood some, but not all of its meaning; through interpretation (of one entry *as* “different”) he articulated the initial meaning and thereby increased his understanding of it.

### **5.5. Negotiating Knowledge**

Our transcript begins with the teacher asking, “And you don’t have anything like that there?” Our analysis of the transcript interprets the meaning of “like that” to refer to a pair of rockets that differ only by nose cone type, such as rockets 1 and 2. But our analysis also claims that this phrase is initially interpreted differently by the various student perspectives. Because group meaning has to be interpreted by individual participants from their own perspectives, there are many possibilities for divergence and misunderstanding.

The openness to interpretive divergence is a powerful mechanism for creativity in group discourse (Rogers Hall, personal communication). It allows different participants to pursue different interpretive lines of exploration of shared themes. Such divergence can continue until it becomes noticeable, possibly causing a breakdown in communication, and the group sets out to resolve the differences. The various discourse methods for establishing convergence of interpretation can be considered forms of *negotiating* knowing.

In our experimental data, prior explicit focus on comparing rockets 3 and 4 made it hard for the students to see rockets 1 and 2 as the thing “like that” to which the teacher’s question was trying to point. The students’ negative responses to the teacher’s hypothetical question apparently violated the perceived social practices of the classroom and motivated the negotiation that gradually shifted the group focus to rockets 1 and 2. Once those rockets were explicitly named, the various interpretive perspectives aligned their references and further progress followed rapidly.

The much touted *synergy* of collaboration has its origin in the negotiation of multiple perspectives. Different viewpoints on the discourse topic interact, are explored and lead to novel results. This takes place at the group level of interpretation. Individual utterances are open to many possible interpretations due to the ambiguity of their indexical references, the elliptical nature of their expressions and the openness of their projections. But within the flow of the group discourse, certain of these possibilities are selected. One person’s response picks up on one of the possible interpretations of a preceding utterance and establishes that as its meaning within the discourse. Through such discourse processes, the meaning of what is said is determined by the interactions of multiple members of the group, not just by the person who made a particular utterance. In fact, it is not the individual utterance that expresses meaning, but the network of consecutive utterances within the situational context. Thus, the meaning is deeply synergistic, arising through the intertwining or negotiation of the individual perspectives within the group situation.

But there are real limits to openness and interpretive creativity. One can attempt to interpret something and fail. This may be due to the resistance of reality: things have meaningful form, particular utility and specific affordances and cannot be arbitrarily

interpreted. Interpretation is a kind of creation/discovery (Merleau-Ponty, 1955) where different things can be tried, but they will not all work. Interpretation is an on-going process, incorporating conjectures and refutations, hypotheses and disconfirmations, trials and revisions. As one listens to someone or reads a text, one constantly and tentatively constructs an interpretation, trying to form a consistent account of the many words, phrases and references. One repeatedly revises and reorganizes as one takes into account new evidence, quickly forgetting the former interpretations and the process of successive revision.

The objectivity of knowledge arises—gradually and tentatively—through the negotiation with reality and with multiple interpretive perspectives through discourse. This social interaction can, for instance, raise issues of evidence or apply standards of scientific argumentation: science is itself a prime example of continuous knowledge negotiation (Donald, 1991; Latour & Woolgar, 1979). The status of scientific theories, particularly in the human sciences, does not contradict their origin in processes of building collaborative knowing, but rather derives from the nature of those processes as methodologically structured and intersubjectively accepted.

## 6. Building Knowing

Now that the elements of building collaborative knowing have been introduced—such as artifacts, situation, meaning, interpretation, tacit knowing, explicit knowing, perspectives and negotiation—we can outline the process by which groups construct meaning and individuals develop their understanding.

### 6.1. Internalization and Externalization

According to Vygotsky (1930/1978; 1934/1986), human intelligence is formed by individuals internalizing artifacts and language that are generated socially, that is, at the group level. We can think of *internalization* as the generation of *cognitive artifacts* (Hutchins, 1999; Norman, 1991). Here, the term “artifact” refers to symbolic or linguistic as well as physical or digital artifacts. “Cognitive” means that the artifact has been transformed into a mental process.

Suppose that one of the students took the data sheet with the rocket statistics that the group had compiled and he remembered the format of the matrix of numbers or some of the key statistics. He could later use this memory to format a data sheet for another project or to make arguments about rocket design. This memory would then be functioning as a cognitive artifact. Its affordances would be different than, but derived from, the physical data sheet artifact. Similarly, the students were able to internalize the teacher’s vocabulary of “different,” “same,” “compare.” By mimicking the teacher’s talk, the students gradually, and with varied success, internalized this mini-language-game of rocket science.

This example suggests that human memory, which is commonly considered to be a biological function, is, rather, a complex involving both inherited capabilities and internalized cognitive artifacts. It is probably built on a biological base of episodic memory, by which many mammals can recall specific events that took place in their past experience and that may be similar to some aspect of a present situation. As part of the

specifically human ability to mimic, people also exercise mimetic memory (Donald, 1991), which allows us to imagine things that are not currently present. The human ability to mediate perception, memory and behavior—especially generating speech, including, eventually, self-talk and silent internal speech—greatly extends our capacity to imagine and express meanings that reference things not in our immediate perceptual environment (Vygotsky, 1930/1978). In interacting socially to acquire local language and practices through mimesis, human infants develop an extensive array of cognitive artifacts, including more sophisticated forms of memory such as temporally structured narrative memory (Bruner, 1990), which in turn let them develop more complex physical and mental abilities.

Even the concept of self, for instance, can be viewed as a cognitive artifact that is socially constructed and internalized through mimicking. Children learn what is “mine” in contrast to what is someone else’s, and adopt a view of themselves through the eyes of the other (Levinas, 1974/1998; Mead, 1934/1962). Hegel (1807/1967) analyzes the emergence of self-consciousness as a result of the creation of physical artifacts produced for other people, and Marx (1844/1967; 1867/1976) sees self-alienation as a result of the distortion of such social artifact production in commoditization. The modern focus on the individual is an historic product of social organization (Adorno & Horkheimer, 1945; Jaynes, 1976). Hence, the individual-as-mind is not a primitive element of theory, but is itself a socially constructed cognitive artifact.

Externalization has often been considered to follow upon internalization, where prior mental representations are expressed in physical forms such as speech or drawing. But in our theory, which does not speculate or hypothesize about mental representations, *externalization* is simply the fact that meaning is embodied in artifacts and sedimented in language. It is unnecessary to speculate on the extent to which that meaning had previously been rehearsed in the internal speech of the people who designed the artifact or uttered the words. In fact, both in terms of the developmental process of the human species and that of each person, meanings are generally internalized first—from some external, inter-personal, group or social form, according to Vygotsky (1930/1978)—before they can be (re-)externalized. So, external meaning generally precedes internal (Hutchins, 1996), rather than the reverse, which is traditionally assumed. We will explore how externalization works in the following section.

## **6.2. The Interpretation of Signs and the Affordances of Artifacts**

The meanings of signs, symbols, terms, phrases, etc. are built up through use. In our transcript, the term “different” takes on a specific meaning through the sequence of its occurrences in the discourse. It is used in conjunction with other terms, in reference to certain rockets, in various functional grammatical roles and as part of several speech acts. Of course, it also brings with it meanings from standard conversational English. All these influences are *sedimented* in the term’s meaning for the classroom group, like the layers of sand sedimented in the Earth’s geology and visible to the knowledgeable eye as traces of ancient history. Just as sand is compressed and transformed into impenetrable rock over time, the past uses of a word are compressed into its meaning (Husserl, 1936/1989). The meaning is shaped by its history long after the details of its episodic uses have been forgotten. Through interpretation, new speakers of the word must learn to read the nuances of its meaning from the occurrences that they experience.

An artifact *embodies* human meaning in its physical form. By definition, an artifact is man-made for some purpose. Its meaning has been designed into its form by a community for whom that artifact is part of their culture. The rocket list artifact, for instance, is a scientific inventory list. It includes a line describing each rocket in the simulation, systematically arranged to facilitate the identification of pairs of rockets differing from each other in only one variable. We say the list “affords” such identification, or that the artifact has this *affordance* designed into it. An affordance is not an objective property of an artifact, but is part of its meaning for a community of use (Gibson, 1979; Norman, 1990; Wartofsky, 1973/1979). Moreover, it is something that individual interpreters must learn to see as an affordance: it is only at the end of our transcript that Chuck can say “I see, I see, I see” about the list artifact’s affordance.

### **6.3. The Cycle of Knowledge Building and Meaning Making**

Building collaborative knowing or constructing shared meaning is a cyclical process with no beginning or end. Any episode starts on the basis of an indefinitely long history of meaning and knowing. It assumes a meaningful language and a world of artifacts, a situation in which everything is already interpreted. Whatever is made explicit was already tacitly known and can only be explicated against an unbounded background of prior understanding—the “hermeneutic circle” (Heidegger, 1927/1996) means that one can only interpret what one already has an interpretation of.

Figure 15-3 represents a number of phases of building collaborative knowing and relates this group process to the individual flow of personal knowing. Here, some of the terminology has been modified from the corresponding figure (figure 9-1) from chapter 9 in order to incorporate the discussion in this chapter. Individual utterances start the public cycle, triggered by some focus of attention against a background of tacit personal understanding. The cycle can eventually lead to the production of shared cultural artifacts, which can be internalized by individual participants, increasing their resources of cognitive artifacts.

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Figure 15-3 goes approximately here

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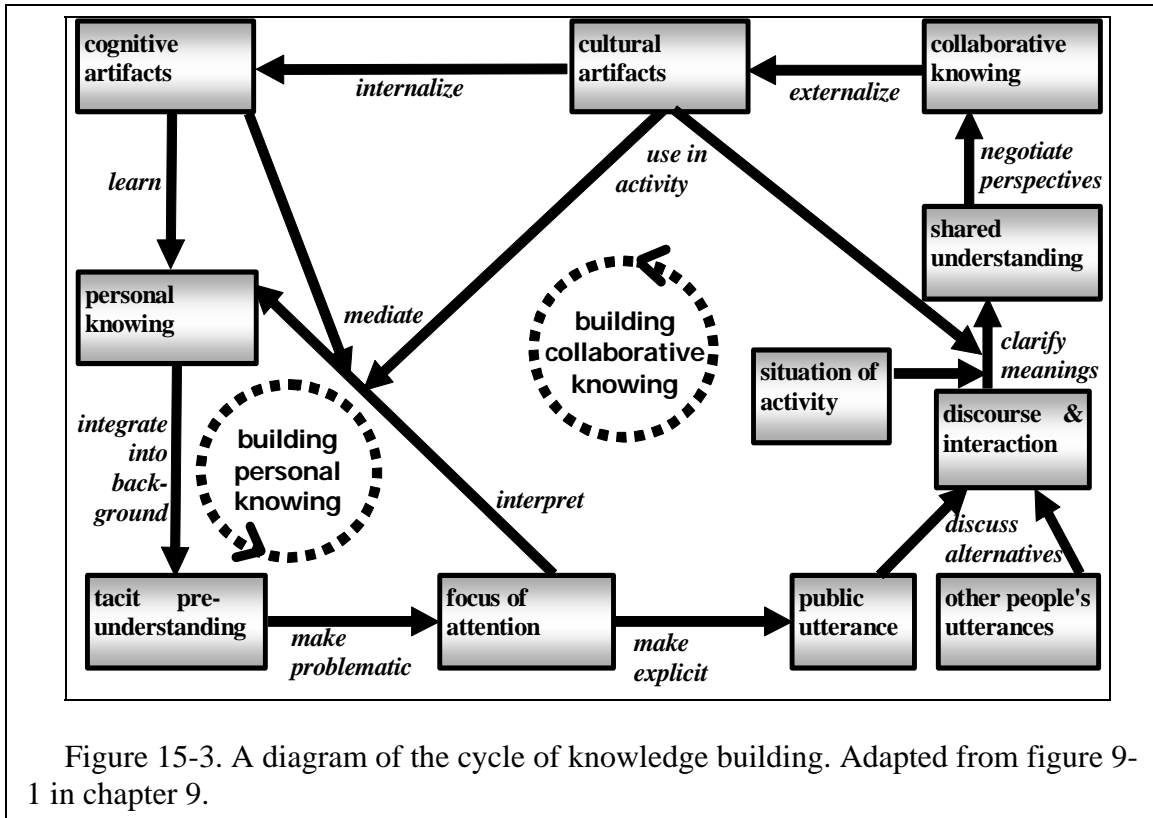


Figure 15-3. A diagram of the cycle of knowledge building. Adapted from figure 9-1 in chapter 9.

In the small-group discourses that drive building knowing, group meanings intertwine subtly with interpretive perspectives that engage in complex negotiations. Unnoticed, new layers of meaning are sedimented in shared jargon. Periodically, persistent artifacts, like documents or pictures, are produced. Through the mediations of internalization processes, these cognitive artifacts can then persist as personal memories, intellectual resources, mental abilities, minds.

Viewed historically, the cycle feeds on itself and spirals exponentially faster. These days, technology mediates the interactions, the artifacts and the access. Building knowing takes place dramatically differently in a technologically produced environment, interpreted from scientific perspectives. The discourse processes in a CSCL discussion forum, for instance, are very different from those in a face-to-face meeting, partially because they take place in written rather than spoken language. The transition from oral to literate society (Ong, 1998) is taking another major step forward with computer-networked communication. The nature and rate of social interaction and of the building of collaborative knowing are undergoing rapid and continuous transformation.

#### 6.4. The Interactive Construction of Knowing, the Situation, Temporality

How is an activity system context interactively achieved by a group discourse? The immediate activity for the collaborative moment in the transcript was established by the teacher's rhetorical question. Both the definition of the immediate task and its accomplishment were carried out discursively. His question was precisely formulated to define a mini activity system that could lead to the desired group knowing. The question was not, however, planned in advance by the teacher, but arose spontaneously as his

reaction to the on-going conversation. His skilful use of such questions was a discursive, rhetorical resource that he put to use in the specific context in an effort to further the larger activity. This is an example of how an activity context was created as a natural and integral consequence of the very on-going discourse that it structured. That is, the context was not a pre-existing and immutable institutional structure, nor was it the externalization of someone's prior mental representations or plans (Suchman, 1987).

It is characteristic of persistent objects that they distort or obscure the apparent history of their creation. Marx (1867/1976) pointed this out for commercial products and called it the "fetishism of commodities." He argued that commodities on the market appeared to have an inherent economic value, whereas his historical, socio-economic analysis showed that their value was based on social relations among the people who produced and exchanged them. Similarly, words seem to have some kind of ephemeral other-worldly meaning, whereas we can deconstruct their meaning and demonstrate how it was constituted in a history of contextualized uses and networks of relationships to other words, artifacts and activities. Artifacts, too, seem to come with objective affordances, but these were designed into them by their creators and must be learned and interpreted anew by their users.

In our theory, collaborative learning—as the extending of group knowing—is constructed in social interactions, such as discourse. It is not a matter of accepting fixed facts, but is the dynamic, on-going, evolving result of complex interactions, which primarily take place within communities of people. The building of knowing is always situated; the situation grants meaning to the activities, language and artifacts that define the extended, inter-related context. Such a cyclical, dialectical process in which people construct elements of the very context that conditions their activity and makes it possible is a process of "social re-production" or "structuration"—the meaningful social situation reproduces itself interactively (Giddens, 1984b). The situation reflects previous social activities, and is transformed by current interactions and by projections of the future. Frequently and unnoticed, interactive knowing crystallizes into seemingly immutable knowledge or facts, just as situated action coalesces into habitual practices, conventional rules and dominant institutions.

Even space and time, as the dimensions within which activities take place, are interactively socially constructed. In section 4.1, above, we characterized the utterances in the transcript as indexical, elliptical and projective, meaning that they referenced unstated elements of the past, present and future discourse or its situation. In making such references, the discourse weaves an implicit pattern of temporal relations. The interactions of a group narrate the topic of discussion by indexing artifacts in the present situation, elliptically assuming references to past interaction and projecting possible futures. Participants in the discourse interpret and understand this woven temporal pattern as an unnoticed part of their involvement in the discourse. In this way, the situational network of meaning is structured temporally as what Husserl (1936/1989), Heidegger (1927/1996) and Schutz (1967) call "lived temporality." Out of the social interaction among people, the following elements get produced, re-produced and habituated: the group itself as an interactive unit, the individuals as roles and mental subjects, the situation as network of artifacts and space/time as dimensions of reality.

## **6.5. The Larger Social Context as Constituted by Designed Artifacts and Sedimented Language**

This chapter focuses on the micro-processes by which the social context is constituted; for instance, how words and artifacts get, preserve and convey their meaning. From these elemental processes that take place primarily in collaborative group interactions, one could then show how larger-scale social institutions and human cognitive phenomena are built up.

An analysis of the role of artifacts (Bereiter, 2002; Donald, 1991; Geertz, 1973; Latour & Woolgar, 1979; Marx, 1867/1976; Vygotsky, 1930/1978; Wartofsky, 1973/1979) views human culture as consisting of immense collections of linguistic, physical and technological artifacts. Social theoreticians (Bourdieu, 1972/1995; Garfinkel, 1967; Giddens, 1984b; Habermas, 1981/1984) show how social institutions and behavioral codes arise from the elemental processes we have discussed and become institutionalized into large-scale social structures that seem impervious to human influence. These views could be summarized as arguing that the social context in which we live is constituted by the products and by-products of building collaborative knowing, taken on a global, historical scale. Just as our own behavior and cognitive skills as individuals are products of group interaction, so the large social structures are interactively achieved, reproduced and reinterpreted in the momentary practices of communities (see chapter 20).

This chapter has attempted to present core elements of a social theory of collaboration. In bringing together terms and approaches from existing theories influential within CSCW and CSCL, it has tried to describe some of the micro-processes (like synergy) that are often left as unexplained mysteries in other writings. Section 1 argued for the need to develop collaboration theory. Section 2 reviewed the empirical example of building collaborative knowing to guide our thinking. Section 3 suggested an answer to the epistemological question of how collaborative knowing is possible by pointing to group interaction as its source. Section 4 analyzed the semiotics of meaning in terms of the situation as a network of relations among words, artifacts and activities. Section 5 addressed hermeneutic issues of interpretation with the ideas of background tacit knowing, personal perspectives and knowledge negotiation. Finally, this section brought these concepts together to see how knowing evolves through a cycle involving externalization of knowing in artifacts and internalization as cognitive artifacts, all within a broader context of social institutions and community culture; this defines an ontology of meaningful physical objects and human abilities that develop through interaction with other people within a shared meaningful world.

## **6.6. This Chapter as a Theory Artifact**

This chapter has not presented a comprehensive and accepted theory. Rather, it has attempted to point in one possible direction for developing a theory of computer-supported collaboration. Part of this theory is an understanding of how meaning, in group interaction, is collaboratively constructed, preserved and re-learned through the media of language and artifacts. This research complex has barely begun to be explored. So, for instance, we desperately need careful investigations of how computer-supported discourse differs from face-to-face discourse in daily conversation and how students and workers learn the affordances of CSCL and CSCW artifacts.

If we self-apply our theory of building collaborative knowing to the process of theorizing about collaboration, we immediately see the importance of coining descriptive terminology, designing effective artifacts and reflecting upon these as a collaborative community in order to achieve the potential of CSCW and CSCL.