Designing for Virtual Communities in the Service of Learning

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An Exploration of Community in a Knowledge Forum Classroom

An Activity System Analysis

Jim Hewitt

The past two decades have witnessed a remarkable transformation in the theoretical landscape of educational research. Classical in-the-head conceptions of thinking and learning are now sharing the epistemic spotlight with the sociocultural and sociohistorical theories of Vygotsky, Leont'ev, and Luria (Kuutti, 1996). These new perspectives argue that learning is fundamentally a social activity, inextricably tied to participation in communal practices (Lave & Wenger, 1991; Rogoff, Baker-Sennett, Lacasa, & Goldsmith, 1995). Accordingly, there has been a growing interest in the notion of community in educational circles, and the ways in which social groupings can be designed to advance individual and collective cognitions.

Like any theory of learning, sociocultural perspectives are susceptible to misinterpretation and oversimplification. The notion that development "is a process of participation in sociocultural activities" (Rogoff et al., 1995, p. 45) offers a new way of thinking about cognition and meaning, but it can also lead to unwarranted optimism regarding the educational efficacy of community-based strategies. While sociocultural theory has been widely interpreted as a call for framing pedagogies around social engagement, it would be a mistake to assume that any form of group activity will yield desirable educational outcomes. The word *community* is popularly (and sometimes erroneously) applied to a broad range of social organizations, from informal Internet chat rooms to carefully crafted models of classroom activity (e.g., CTGV, 1992; Brown & Campione, 1990; Riel, 1992; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). Clearly, some kinds of community engagement offer more educational promise than others. Thus, the research challenge is not one of drawing overarching conclusions regarding the efficacy of community models in general, but rather one of understanding how communities can be designed to effectively support individual and collective growth.

Over the past decade, the introduction and rapid expansion of Internet technologies have allowed communities to have a virtual existence

in addition to, or in place of, conventional face-to-face interaction. This chapter seeks to improve our understanding of the complex relationships that can exist between the online and face-to-face worlds, and the ways in which communal practices and supports can be distributed across these modalities in pedagogically powerful ways. The focus of analysis is on a grade 5–6 classroom instantiation of an educational community model called a Knowledge Building Community (KBC) (Scardamalia & Bereiter, 1994). The core work of the class takes place "virtually" in an asynchronous electronic environment, but many aspects of online behavior are shaped by daily face-to-face interactions. No effort is made to classify this particular community as virtual or face-to-face, since such labels fail to capture the fluidity with which participants move from one medium to the other. The chapter begins by describing some of the characteristics of a Knowledge Building Community and how a KBC relates to the more general notion of *community*. This is followed by an Activity System analysis of a KBC that examines the distribution of power and responsibilities, the framing of individual and collective goals, and how online and face-to-face elements can combine to support learning.

WHAT IS A KNOWLEDGE BUILDING COMMUNITY?

A knowledge building community (KBC) is a type of community of practice (CoP). Barab, MaKinster, and Scheckler (this volume) describe a CoP as being characterized by: (1) shared knowledge, values, and beliefs; (2) overlapping histories among members; (3) mutual interdependence; (4) mechanisms for reproduction; (5) a common practice and/or mutual enterprise; (6) opportunities for interactions and participation; (7) meaningful relationships; and (8) respect for diverse perspectives and minority views. However, a KBC is a special kind of CoP, one in which the primary enterprise is knowledge creation rather than the construction of specific products or the completion of tasks (Riel & Polin, this volume). Academic research teams serve as a prototypical example. The members of a research team are expected to continually work toward the production of new knowledge, and their day-to-day responsibilities (writing papers, collecting data, presenting at conferences) are in service of that larger objective. Scardamalia and Bereiter (1994) propose that the research team model can be applied to many kinds of organizations (e.g., corporations, elementary and secondary classrooms, clubs, and even families).

As might be imagined, transforming a classroom into a KBC requires a significant shift in classroom norms and student and teacher identities. For students, the challenge is no longer one of completing teacher-designated tasks (e.g., worksheets, assignments, projects), but one of actively and collaboratively defining research problems that interest them, developing plans, identifying intellectual impasses, synthesizing ideas,

and generally working with others to make sense of their area of inquiry. To support these kinds of activities, Scardamalia and Bereiter (1994) have created an online environment called Knowledge Forum (formerly known as Computer Supported Intentional Learning Environments, or CSILE). Knowledge Forum is a networked educational software program in which learners publish multimedia "notes" in a collaborative space and continually push forward the boundaries of communal knowledge (Scardamalia et al., 1989; Scardamalia et al., 1992). The teacher is seen as the expert learner in the classroom, one who supports and mentors students in their knowledge building efforts. Class investigations typically last for weeks, or even months. These investigations evolve in an iterative style, where discoveries inspire new questions that continually drive the research deeper.

To what extent is a classroom-based KBC a genuine community? At first glance, it appears to fit most conventional definitions. For example, it is consistent with Barab and Duffy's (2000) description of a CoP: "a collection of individuals sharing mutually defined practices, beliefs, and understandings over an extended time frame in the pursuit of a shared enterprise" (Wenger, 1998, p. 36). On the other hand, Barab and Duffy also point out that it is difficult for most classrooms to be genuine communities. One problem is that a class often lacks the historic context of conventional communities (Barab & Duffy, 2000). There is no heritage of shared goals, beliefs, and practices, nor is there a dynamic membership, where participants have overlapping histories and newcomers work alongside established practitioners. A second problem concerns the authenticity, or legitimacy, of student activity (Barab & Duffy, 2000). Schoolwork generally does not have meaning or purpose beyond the walls of the classroom. Students spend most of their time generating contrived products (projects, essays) as a means of learning course content, but the products themselves have little value beyond assessment. Lave (1993) refers to this as the commoditization of knowledge and learning in schools.

The implications of the aforementioned problems for classroom-based KBCs are unclear. Concerns about the authenticity of student activity may be less of an issue in KBC classrooms than in regular classrooms. Students in a KBC define problems of understanding that are personally relevant to them and then work to resolve them. There are no products to speak of – no final presentations or essays – just the preserved trace of electronic discourse. The students' goal is an intrinsically meaningful one: to deepen their personal and collective knowledge in a particular domain area. Thus, Barab and Duffy's (2000) concerns about authenticity may not be applicable to knowledge building classrooms. The knowledge constructed in such classrooms is not a commodity, but something that the participants find personally valuable and that the community as a whole legitimizes.

Concerns about a lack of historical context are more germane to knowledge building classrooms. Some split-grade classes (like the one described later in this chapter) do have a sense of continuity, since students cycle through the class over several years. However, many Knowledge Forum classrooms are reconstituted entirely each September. Naturally, they lack a sense of history. One possible way to think about these classrooms is to classify them as *new communities* or *proto-communities* – communities in the early stages of development. In the initial stages of any community, everyone is a novice and roles, protocols, practices, and tools have yet to be established. In much the same fashion, KBC classrooms are populated by newcomers who slowly develop their own rules, knowledge base, and sense of identity. As the school year progresses, pockets of expertise begin to develop, and artifacts emerge that have meaning for classroom members. However, the key distinction between a conventional community and a KBC is that the latter does not always have an opportunity to fulfill its potential. When the academic session ends, the class is disbanded, and the cycle starts anew the following year.

One argument in favor of using the word community to describe Knowledge Forum classrooms is purely pragmatic: a phrase like *knowledge building community* evokes a sense of a paradigmatic shift in teaching practice, which is important for teacher development. Traditional school culture is extremely resistant to change (Elmore, 1996), and innovative instructional approaches are constantly at risk of being routinized or subsumed into familiar, comfortable categories (e.g., "group work"). A phrase like knowledge building community is valuable precisely because it suggests a methodology that separates it from traditional teaching practice. The word community, in particular, helps convey many of the essential attributes of the KBC model. Thus, regardless of whether or not a classroom can be technically classified as a community, it may be helpful, in some circumstances, to label it as such.

This chapter examines a specific grade 5–6 classroom that adheres to many of the KBC practices described by Scardamalia and Bereiter. The teacher of this class is widely considered to be one of the more successful and effective Knowledge Forum instructors. His transition from conventional teaching to teaching with Knowledge Forum has already been documented in a previous study (Hewitt, 2002). The following analysis will examine the relationship between online and face-to-face processes in his class, and how the two come together to support community. Activity Theory is used as a framework for this investigation.

ACTIVITY THEORY

A sociocultural shift in the thinking of the educational psychology community has called into question the validity of traditional research methodologies. In particular, researchers like Lave (1988) propose that knowledge is not something that simply exists in the head, but also exists in

the way that social groups communicate, make use of symbols and tools, and organize their belief systems. Learning, by extension, is a fundamentally situated activity in which expertise is gained by taking a legitimate role in the ongoing activities of a community and gradually moving to fuller participation (see also Brown, Collins, & Duguid, 1989 and Collins et al., 1989). However, if cognitions are fundamentally situated, then research that neglects the social and contextual dimensions of learning are at risk of drawing unwarranted conclusions about complex phenomena (Salomon, 1995). Such ideas call into question the epistemic assumptions of traditional experimental methodologies and argue for new forms of educational research. The alternative to conventional experimentation, and its philosophy of simplification by isolation, is to observe how individuals learn *in situ* – that is, in authentic, real-world contexts like a school classroom.

A classroom is a complicated environment in which many interacting factors influence the learning process. Discerning how and why cognitions change at a detailed level is extremely difficult and open to interpretive bias. Indeed, this complexity is one of the reasons why reductionist approaches were originally so popular. However, the apparent trade-off between ecological validity and rigor may only be problematic if the individual remains as the unit of study. Since theories of situated cognition suggest that learning involves much more than just those processes that go on in the head, it may be appropriate to consider larger units of analysis (Barab & Kirshner, 2001). Salomon (1995) suggests that it is these larger "composites" on which we should be focusing.

> The meaning of the configuration, Gestalt, composite or constellation of factors is qualitatively different from that of its components. It is the composite that students and teachers experience; it is that composite which they interact with, not each of the ingredients taken one at a time; and it is that composite that we should be studying. (p. 17)

The problem, as Rogoff (1997) points out, is one of identifying units of analysis that capture the events of interest while simultaneously honoring the dynamic interdependence of individual, social, and cultural influences. Activity theory (AT) provides one useful lens for studying these interrelationships. As its name suggests, Activity Theory posits that human learning is fundamentally grounded in activity (thus blurring the traditional distinction between knowing and doing). Activity Theory is neither a methodology, nor is it a prescriptive or diagnostic tool (Jonassen & Rohrer-Murphy, 1999). Rather, it serves as a philosophical framework for studying the interweaving of human praxis at the individual and social levels. Engeström (1990) describes AT as an interdependent view of human activity involving the individual (or subject), tools, a problem space (or object), the community of people who are similarly concerned with

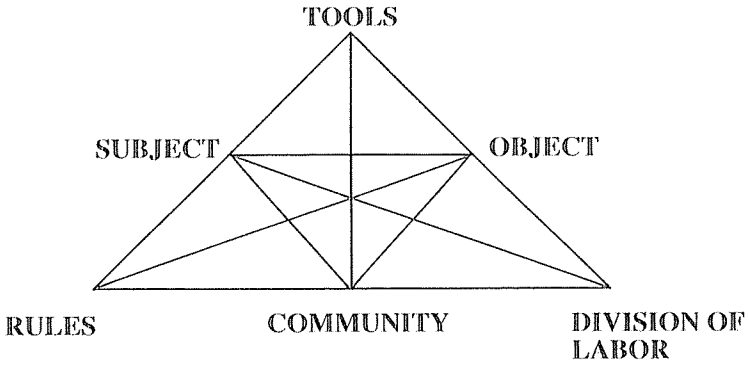


FIGURE 8.1. The components of an Activity System

the problem, the division of labor between community members, and the conventions (rules) regarding actions.

A triangular diagram (Figure 8.1) is often used to depict this relationship. Note that the activity of the individual (top three components) is not viewed in isolation, but is tied to the larger cultural context. Human activity is socially bound and is not merely the sum of individual actions (Engeström, 1987, 1990, 1993; Kuutti, 1996). Furthermore, Activity Systems are dynamic and may evolve over time. For example, changes in the design of a tool may influence a subject's orientation toward an object, which in turn may influence the cultural practices (rules) of the community. Or, changes to cultural practice may inspire the creation or reworking of a tool. Perturbations at any one point produce ripples, and occasionally, major transformations across the system. Thus, the model provides a composite view that recognizes the socially distributed nature of human activity, the activity of the individual, and the transformative nature of activity systems in general. And as Wells (1994) points out, it suggests ways of inducing cultural change:

> [The Activity Theory model] also draws attention to possible points of leverage in the attempt to overcome the sequestered nature of schooling. For example, changing the nature of the rules that prescribe the sorts of actions that participants engage in and the expected outcomes, modifying the division of labor, or valuing other tools in addition to the textbook – for example, collaborative, exploratory talk – all create quite different activity systems, and ones that may encourage rather than resist student initiative and creativity. (p. 5)

Figure 8.2 serves as a rough model of the Activity System of a typical classroom. Most classroom activities involve students (subject) using pencils, erasers, calculators, and so forth (tools) to complete a task (object) that has been assigned by the teacher. This activity is constrained and guided by the rules and norms that govern classroom behavior (rules). The outcome,

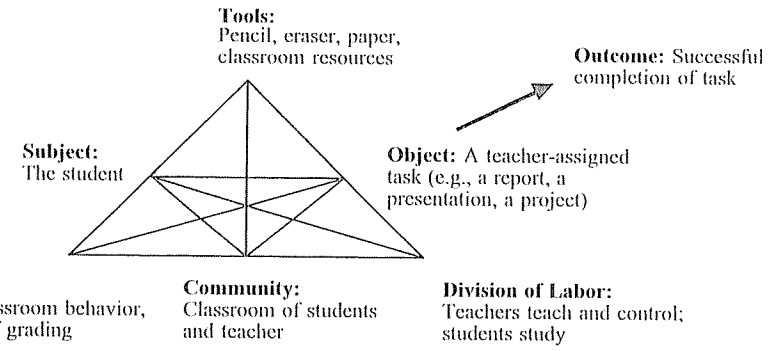


FIGURE 8.2. A typical elementary classroom Activity System

or product of this system, is student success or failure to complete the task according to the instructor's predefined criteria. Obviously, this Activity System is a rather generic one, and the components are not deeply fleshed out. However, Figure 8.2 does serve as a representation of a common – and in many ways dominant – task-based classroom Activity System, one that has endured in schools for decades.

The Activity System of a KBC takes a form that is quite different from that of Figure 8.2. Scardamalia and Bereiter (1993) describe a classroom-based KBC as follows:

1. There is a sustained study of topics in depth, sometimes over a period of months, rather than superficial coverage.
2. The focus is on problems rather than on categories of knowledge: not "the heart" but "how does the heart work?"
3. Inquiry is driven by students' questions. The teacher helps students formulate better questions and encourages them to reformulate questions at higher levels as inquiry proceeds.
4. Explaining is the major challenge. Students are encouraged to produce their own theories to account for facts and to criticize one another's theories by confronting them with facts.
5. Although teachers pay close attention to how each student is doing, the day-to-day focus is progress toward collective goals of understanding and judgment rather than on individual learning and performance.
6. There is little schoolwork of the conventional kind, where the students are working individually but all doing the same thing. More typically, students work in small groups; each group has a different task related to the central topic and plans how to distribute work among its members.
7. Discourse is taken seriously. Students are expected to respond to one another's work and are taught how to do so in helpful, supportive ways.
8. The teacher's own knowledge does not curtail what is to be learned or investigated. Teachers can contribute what they know to the discourse, but there are other sources of information.

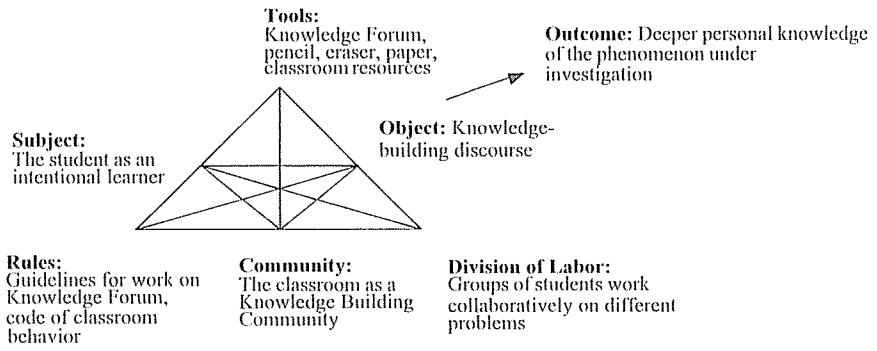


FIGURE 8.3. The Activity System of a Knowledge Building Community classroom

9. The teacher remains the leader, but the teacher's role shifts from standing outside the learning process and guiding it to participating actively in the learning process and leading by virtue of being a more expert learner. (pp. 14–15)

Using this description, the Activity System of a KBC can be represented by the framework in Figure 8.3.

Comparing the Knowledge Forum Activity System (Figure 8.3) to that of typical classrooms (Figure 8.2) reveals key differences. In a regular classroom, the product of activity is often a report, a presentation, or a project. Knowledge Forum classrooms, by comparison, often have no tangible product beyond that of written discourse (Bereiter et al., 1997). In a sense, the product and the process of inquiry are the same thing. Rather than focus on completing a teacher-designated task, students are encouraged and expected to take an intentional stance on their own learning (Bereiter & Scardamalia, 1989).

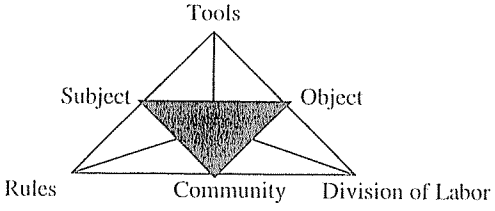
A CASE STUDY OF A KNOWLEDGE FORUM CLASSROOM

The following case study employs an Activity System framework to analyze individual and communal practices, both face-to-face and online, in a grade 5–6 Knowledge Forum classroom. The research methodology can be characterized as naturalistic inquiry supported by both quantitative and qualitative data (Guba & Lincoln, 1994). Data were gathered over a span of three years from researcher field notes, teacher interviews, student interviews, the contents of the Knowledge Forum database, and videotaped interactions between the instructor and students. The class contained between 25 and 32 students each year and typically 8 to 10 of the grade 6 students would have also been in the class during grade 5. Each student worked on Knowledge Forum for approximately 30 minutes per school day. The class studied a series of science-related topics

(e.g., human biology, electricity, plants and animals) with each topic lasting approximately two months. Over the three-year span, the researcher spent approximately 150 hours in the classroom. The researcher conducted interviews, observed class activity, and provided occasional technical support for students, but did not assist or advise students with regard to their Knowledge Forum investigations. Neither the researcher nor the teacher participated extensively in the Knowledge Forum database.

In the following investigation, online and face-to-face processes are examined at both an individual (subject) and social (community) level. To carry out this analysis, the subject-community relationship is highlighted on the Activity System triangle, and this relationship is considered relative to each of the remaining Activity System components. This arrangement yields the following four subtriangle analyses: (1) subject-community-object; (2) subject-community-division of labor; (3) subject-community-rules; and (4) subject-community-tools. Considered collectively, these analyses are intended to provide a rich description of an exemplary Knowledge Forum instructor's classroom.

Subject-Community-Object: Online Discourse as an Individual and Collective Object of Analysis



The learner discourse on Knowledge Forum (object) was the focal point of the community. It held the questions, theories, findings, and summaries of the entire class. At the beginning of a unit, students would be prompted to think about what they didn't understand about the given subject area. For example, if the topic was human biology, students might wonder where blood comes from or how the human eye works. These questions would serve as starting points in Knowledge Forum, and it would be the students' responsibility to make progress on both the questions that they contributed and those of their classmates in the shared online environment. "Progress" in this case is defined as adding notes that advance the existing discourse (e.g., providing a new theory, asking a question that no one had previously considered, or sharing information that had been obtained from resource materials). Usually, students were also required to associate an epistemological scaffold (e.g., "My Theory," "I Need To Understand") with each of their contributions, giving rise to discussions like the one in Example 8.1 involving three students (AR, JD, and AK).

Example 8.1. A Knowledge Forum discussion about nerve cells

PROBLEM (AR): How does a nerve cell work?

MY THEORY (AR): I think a nerve cell is just like any other cell except it can send messages to other parts of the body and it can feel. For example: Let's say an arm has been hurt. A nerve cell would feel that and then would send a message to the brain saying that the arm has been hurt.

MY THEORY (JD): I agree with you but where you say that the nerve cell sends messages to the ear. I think that the brain tells the ear.

MY THEORY (AK): I think that the nerve cell sends messages to the brain not the parts of the body that's been hurt. I think after the brain receives the message it reacts to them.

NEW INFORMATION (AR): Nerve cells are very long. They are longer than any other cell. Nerve cells have thin parts sticking out that send the messages. These parts are called axons.

I NEED TO UNDERSTAND (AK): How does the body react to the messages the nerve cell sends?

NEW INFORMATION (AR): Let's say the arm has been hurt. First an arm nerve cell will send a message up to the brain, through the spinal cord, saying that the arm has been hurt. Then the brain will send a message to, for instance, a hand saying that the arm has been hurt and needs help. Finally the hand will reach out and help the arm, maybe by squeezing it or rubbing it. I will try to explain this more clearly in my chart called a nerve cell.

I NEED TO UNDERSTAND (JD): What kind of parts are there in a nerve cell?

NEW INFORMATION (AR): A part in the nerve cell is the myelin. This is a very thick layer that covers the axon. Axons are another part of a nerve cell. Axons are long and skinny and can be as small as a fraction of an inch to three feet! Another part is the dendrites. They are very small and stick out from the cell. Nerve cells have a nucleus just like any other cell. Please look at my chart parts of the nerve cell.

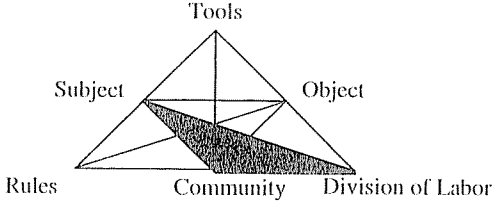
Typically, the class worked on several dozen discussions simultaneously. Collectively, these discussions served as a reification of the evolving understanding of the entire class. The global accessibility of this corpus, combined with the teacher's emphasis on making progress, led to a reciprocal and mutually reinforcing relationship between the classroom as a whole (community) and the individual learner (subject). To make a worthwhile contribution to a Knowledge Forum discourse, a student had to first learn what the community already knew about the issue at hand (Scardamalia & Bereiter, 1996). Thus, individual learning was continually driven forward by a need to build on the community's existing knowledge base. Communal knowledge, in turn, was continually advanced by the ongoing

contributions of individuals. Each time a student introduced a new question or a new theory, it upped the ante for the rest of the class who were now responsible for pushing the discourse even deeper.

Focusing on knowledge advancement and understanding was a common theme in the teacher's discussions with the class. Some students initially found it to be a difficult concept to grasp. After four or five years of conventional schooling, they were accustomed to producing specific artifacts for the teacher (e.g., a story, or a project). Few of them were initially comfortable with the notion of focusing on something as intangible as personal comprehension, and in September there was sometimes a clash between the new students' expectations and the teacher's efforts to foster knowledge building. For example, new students would be more reluctant to offer their personal theories, for fear of being wrong. However, the teacher's practice of describing the class as a research team and his use of experienced grade 6 students (i.e., those who had participated in the class during the previous year) as mentors to the grade 5 students helped quicken the pace of enculturation.

Face-to-face discourse in the classroom was unlike the discourse on Knowledge Forum. The latter was organized around epistemological scaffolds and was specifically targeted at making progress on the problems of understanding. Face-to-face discourse, on the other hand, was used for a much wider range of purposes (e.g., how to use certain features of the software, deciding what problems the group would pursue next, alerting others to database developments, and the challenge of finding resources that pertained to their particular online interests). One notable aspect of both kinds of discourse is that they frequently included phrases like "my theory" or "John's question" or "her findings." Such phrases are not usually heard in traditional classrooms. However, Knowledge Forum turns theories, questions, and findings into screen objects that can be pointed at, organized, and talked about. A theory is not an ethereal construct in a Knowledge Forum classroom, but a meaningful community artifact.

Subject-Community-Division of Labor: Roles and Responsibilities of Community Members



Typically, in elementary classrooms, everyone in the class is taught the same curriculum material. In the case study classroom, the entire class worked

together on the same overarching topic, but different students specialized in different subdomains. For example, if the topic was human biology, one group would become experts on the respiratory system, another group would become experts on vision, and so forth. Rather than providing all students with the same broad (and shallow) biology curriculum, the labor was divided so individuals could investigate personal areas of interest in depth.

The teacher arranged the classroom schedule so that each student had 30 minutes per day on Knowledge Forum, and an additional 15 to 30 minutes for research in the library or at their desks. Virtually all of the notes in Knowledge Forum belonged to the students. The teacher monitored developments in the Knowledge Forum database, but rarely contributed notes of his own.

As the unit progressed, students were expected to submit a few of their notes to the teacher for grading. Notes that were grammatically correct, were free of spelling errors, and made a reasonable contribution to the class discourse were assigned a "published" designation in the database. The teacher adjusted the publication criterion to match the needs and abilities of each learner. He felt it was important to challenge each student, but not set standards so high that publication was impossible for some individuals. Report card grades were determined, in part, by the quantity and quality of published notes. The scientific accuracy of the student submissions was not one of the criteria for publication. Some student notes contained misconceptions.

To publish a note, a student would approach the teacher at his desk during the Knowledge Forum work period. Videotaped studies of these exchanges indicate that the teacher used these one-on-one meetings as opportunities to suggest profitable directions for future inquiry, or to raise issues that the student had not previously considered. The discourse in Example 8.2 transpired when the teacher was asked to publish a student's theory that the cerebrum was responsible for actions like walking and talking.

Example 8.2. A videotaped teacher-student exchange

[*Teacher reads the student's note while the student stands by.*]

TEACHER: Oh, that's a good idea . . . so do you think the memory is the most important . . . do you think you first have to remember something even . . . even if you are thinking about walking it has to go through the memory process and then whatever happens after that . . .

STUDENT: But you still have to remember how to do it, cause I think once you learn it, you still remember it, you still have to remember it when you want to do it . . .

TEACHER: ...and you still have to decide you want to do it and you think that happens in the cerebrum.

[2-*second pause*]

TEACHER: Have you ever heard the expression, "Running around like a chicken with its head cut off?" It's an old expression referring to people who are confused, hyperactive, things like that... the expression comes from when farmers used to decide they want to kill a chicken for supper, so they'd cut its head off and the chicken would still run around. How do you explain that if the cerebrum is not even there?

STUDENT: [*Pause*] Well, maybe they... maybe they just... it was a reflex or something?...

TEACHER: Yeah... What is a reflex?

STUDENT: A thing you do automatically without really thinking about it.

TEACHER: So do you think the cerebrum is involved in reflexes?

[*Student smiles but doesn't answer*]

TEACHER: Be nice... well maybe in some of your readings you might have a look at that.

STUDENT: [*Nods*] Yeah, I have some books.

[*The teacher publishes the student's note and the student leaves. Ten minutes later, the student returns with a reference book and points to a section entitled "Actions and Reflexes." The teacher pages through it.*]

TEACHER: This looks like a good book. I'll also take a look through some of my books and see if I can find more information.

STUDENT: Thanks. [*Leaves*]

The teacher chose to use publication as his primary vehicle for coaching students. He rarely wrote notes to them in Knowledge Forum. Interestingly, the instructor's lack of online presence was at odds with Scardamalia and Bereiter's (1993) recommendation that teachers participate in Knowledge Forum as co-learners and mentors. When queried, the instructor's rationale for his lack of online involvement was as follows:

TEACHER: If I were to write in the database, I'd have to do all of that after the students had left, so I think that method is too similar to methods in which the teacher assigns work to be done, and the student does it, and then the teacher marks it after hours and returns it to the student. It becomes some sort of automatic process that everyone gets involved in. It's not very interactive. There are many opportunities for misunderstanding, or worse, for the student not to notice, or not to bother with, what the teacher has written.

Thus, in part, the teacher didn't feel that he had the time to work in Knowledge Forum. However, beyond issues of time constraints, he believed that the software was not interactive enough for his purposes. While Knowledge Forum served as a useful support for collaborative student inquiry, it did not, in his view, have the immediacy required for exchanges like the one in Example 8.2. Consequently, the students were wholly responsible for online knowledge building, and the teacher was responsible for observing their progress and coaching individuals privately.

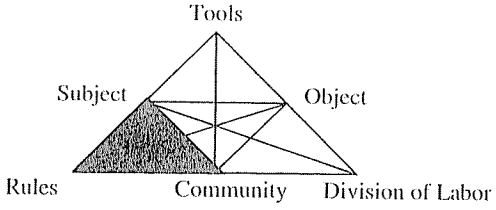
In some respects, the teacher organized the division of labor in such a way that he stood outside the KBC, rather than working within it. During his first few years as a Knowledge Forum instructor, he contributed frequently to the database. Over time, he gradually reduced his online involvement in favor of greater face-to-face interaction with students. This decision involved trade-offs. Had he assisted students through Knowledge Forum, his suggestions would have been preserved and made available to the entire class. On the other hand, coaching students in person permitted more rapid conversational exchanges than would be possible in asynchronous environments, and it reduced the risk of embarrassing a student in front of his or her peers. It may have had other benefits as well. The teacher commented that "students who come to me to have their notes published are ready to talk about their research." He felt that these students were more likely to be focused on the contents of their notes and intellectually receptive to his suggestions.

The teacher felt uneasy about some aspects of his publication methods. On one hand, he wanted students to take increasing responsibility for the regulatory processes governing their own intellectual growth. On the other hand, he felt that he needed to use his publishing scheme as a task-based incentive for quantity and quality in student online productions. The problem was that a heavy focus on the latter could subvert the former. On several occasions, the teacher expressed concern about whether his marking scheme was unintentionally undermining his efforts to foster student ownership of knowledge building activity. What were the students' goals? Were they genuinely taking charge of their own investigations and trying to push forward the boundaries of classroom knowledge? Or were their actions primarily aimed at publishing as many notes as possible? This was an ongoing dilemma for the teacher, and while he tried to keep knowledge building as the primary focus, he also recognized a need to establish standards that would bear on report card grades.

To summarize, online and offline processes served different but interrelated functions that were tied to classroom roles and responsibilities. Students were expected to work in Knowledge Forum toward becoming experts in areas of their own choosing. The teacher did not participate directly in online discourse, but used a publication mechanism as a means of coaching students, face-to-face. This allowed him to evaluate performance

and tailor standards of achievement to the needs and abilities of individual students. Thus, students became classroom experts in various subdomains and interacted with each other in the online environment, and felt a sense of ownership over that environment, while the teacher mentored them privately and in-person.

Subject-Community-Rules: Guidelines for Knowledge Building Activities



In addition to traditional classroom codes of behavior, the instructor also introduced guidelines for student work in Knowledge Forum (see also Hewitt, 2002). The guidelines included:

- Students should associate an epistemological scaffold (e.g., "My Theory," "I Need To Understand," "New Information") with each Knowledge Forum note. One of the effects of this rule was to change the language of the class, as these words became increasingly used in face-to-face settings as well as in Knowledge Forum.
- All Knowledge Forum investigations should begin with a problem statement. The students were told that certain kinds of problems were more educationally productive than others. For example, the problem, "How many bones are in the human hand?" doesn't lead to a very deep investigation. However, questions of the form "How does *x* work?" or "Why . . . ?" lead to deeper analysis.
- Students were asked to not bring reference books with them to the computer. The teacher was concerned that students might copy passages or phrases from the reference book into Knowledge Forum without fully understanding the content. Instead, students were encouraged to take brief notes at their desk, and make an effort to understand what they were reading. They would then take their handwritten notes to the computer during their Knowledge Forum session.
- To encourage students to construct explanations, students were expected to use "My Theory" in response to "Problem" and "I Need To Understand" entries in all online discussions. The teacher introduced this guideline to encourage conjecture-building. Students were discouraged from consulting classroom resources until after they had shared their theories about the question at hand.

- Students were given instructions regarding constructive criticism, including strategies for responding to each other's work in a positive fashion. The teacher explained that most "My Theory" notes would be incorrect and it was important to not criticize people for early explanations, which tend to be inaccurate.

Perhaps the most distinctive rule in this community was the emphasis on student theories and the tolerance of partial understandings or misconceptions. The teacher wanted the students to feel safe proposing explanations and sharing them with their classmates. Students were allowed to disagree with one another, but only in ways that respected each other's work. The teacher modeled this behavior in his own face-to-face interactions with students. For instance, in the discussion in Example 8.3, the teacher is uncritical of a student's (incorrect) hypothesis that pain occurs when blood fails to provide cells with an adequate supply of oxygen.

Example 8.3. A videotaped teacher-student exchange

[*Teacher reads student note while student stands by*]
TEACHER: So you think pain is caused by a lack of oxygen.
STUDENT: Yep.
TEACHER: What makes you think that?
STUDENT: Well when you get cut – the blood, the blood usually comes out. The blood comes out which momentarily stops the flow of blood. Because you keep bleeding.
TEACHER: Yeah? Stops the flow of blood?
STUDENT: Yes, because –
TEACHER: To where?
STUDENT: To wherever it was going.
TEACHER: Oh I see! So, you're saying, those cells . . .
STUDENT: The blood carries oxygen . . .
TEACHER: . . . don't have their oxygen any more?
STUDENT: Yeah.
TEACHER: They start to hurt.
STUDENT: Yeah.
TEACHER: Oh that's interesting!
[*They both start to look at the screen together as the teacher scrolls through the note.*]
STUDENT: Maybe oxygen keeps the blood from hurting.
TEACHER: Well first, yes, if this is going on . . . I'd like to know, if it's ok with you, why the loss of oxygen causes pain. We're not sure if it does yet. You should maybe put . . .
STUDENT: [*suggests a phrase to insert into his note*] "If it does?"
TEACHER: [*repeats*] "I would like to know why, if it does, why loss of oxygen causes pain."

TEACHER: [*Pointing to a spelling error*] This I think we need to revise a bit more. Did you run it through? [*the spell-checker*]
STUDENT: I did in spots.
TEACHER: Did you? Well just run it through and bring it back and we'll take a look at it. That's an interesting idea.

In the dialogue in Example 8.3, the student hypothesized that some cells failed to receive an adequate amount of oxygen when blood escaped from the body through a cut. This absence of oxygen causes pain. It is not clear if the student believed his explanation was scientifically accurate. However, he had produced a promising hypothesis because it combined some of his knowledge about blood (it carries oxygen) with his observation that cuts are painful. What is notable in this example is the teacher's willingness to allow (at least temporarily) a student to entertain a misconception, as long as the explanation was rational given the student's knowledge of the world. Episodes like this one suggest that the teacher placed higher value on reasoning, risk-taking, and the invention of explanations than on making sure that the students were aware of the scientifically accepted accounts.

TEACHER: . . . we have never allowed students before to express [their theories]. In fact, the name of the game in school is to keep them hidden, not to bring them out in the open, not to ask a question in case it's a stupid one, not to write something down in case it's the wrong answer. Instead now with this format we are encouraging students to be unafraid of saying what they actually believe and then work towards seeing whether or not they are correct.

One should not interpret the teacher's support of student theories as acceptance for all kinds of student-invented conjectures. The teacher often walked a delicate line between allowing students to express and explore their theories, and keeping them from floundering down intellectual blind alleys. He wanted to provide students with the freedom to define and pursue their theories, and to feel safe in doing so. However, he also felt a need to nudge students toward more promising lines of inquiry should their theories prove to be unproductive.

Much of the teacher-student discourse appears to be consistent with Fosnot's (1989) four-step mentoring strategy:

1. The mentor learns the protégé's point of view through careful listening and probing.
2. The mentor teaches by inquiring at the "leading edge" of the protégé's thinking and by attempting to facilitate disequilibrium.
3. The mentor constructs a line of inquiry meaningful to the protégé and the protégé constructs a line of reasoning meaningful to the mentor.
4. The mentor acknowledges that the protégé has the intellectual freedom to adopt and modify the pedagogical orientation of his or her choice (Fosnot, 1989, p. 97).

The effort to provoke disequilibrium is clearly visible in the Example 8.2 "chicken with its head cut off" dialogue. During that discussion, the teacher invented a scenario that challenged the student's theory – a challenge that ultimately led the student to a more productive line of research. The dialogue in Example 8.3 illustrates the teacher's willingness to support student explanations that may be scientifically inaccurate, but are coherent and sensible given the learner's world view.

In an attempt to better grasp the community's emphasis on theory building, a series of student interviews was conducted at the end of the third year. The sample of grade 5 and 6 students who took part in this exercise contained a disproportionate number of high achievers, so their responses may not be entirely representative. However, there were some interesting trends and these are presented with the caveat that a more rigorous investigation is required. The responses from three questions are examined:

Interview Question 1: *What is the most important thing to do when you are trying to learn something?*

An examination of the responses reveals two re-occurring themes. The first is the importance of identifying what you need to understand. For example:

RACHEL: I think the most important thing is you should understand your problem first and you know what you are trying to learn. And then go to different resources, look at different books, to see if there is different information in them. Because a lot of books have . . . if you compare two books, sometimes they have different information.
JULIE: I think it is to understand the problem and then to think about what you could learn if you researched it in a certain way. Supposing you had a topic on static electricity, you could think of all the different aspects of electricity, and see which one you wanted to learn about.
TODD: Well first you have to understand what you are trying to learn. And if you don't do that you might not get the right information, because if you don't quite understand the problem, you might . . . I am not sure.

A second theme running through many of the responses was the notion of making understanding a key part of the process:

BILL: I think that you should understand what you are trying to learn first, and not, like . . . when you read something and you know what it says and you know what it means . . . well, you don't know what it means, but you know what it says and you say, I read it. That is not . . . like, learning, you have to understand how it works and how it fits together with your problem.

MARGE: I think that the most important thing when you are trying to learn something is to understand what you are trying to learn, and not just memorize it, just try and understand what it is.

Both themes were effectively combined in one student's response:

NANCY: I think the most important thing to do is understand the problem and understand the new information. Because if you understand the problem, then you are able to make sure that your answers are direct and that they answer the question as well as possible. And if you get new information, if you make sure you know exactly what all the new information means, then you are able to make it make more sense to the people reading and make more sense to yourself. It will make more sense to yourself if you understand the new information in the problem.

Interview Question 2: *How can you tell when you have learned something?*

Again, several types of responses were identified. Some students reported that they could tell they had learned something if they could respond to other people's questions.

JIM: Because I know it, like if somebody were to ask me about it I could just tell them right off. I just know it.

ANNE: I can, if somebody asks me a question about it, if I am able to answer it to [*inaudible*] what the person asked.

For other students, knowing that you've learned something is more of an internal process. The following student related it to an increased ability to create new explanations that "fit together" and "make sense":

NANCY: I think I can tell if I have learned something when I am able to form substantial theories that seem to fit in with the information that I have already got. So it isn't necessarily that I have everything, that I have all the information, but I am able to piece things in that make sense, and to form theories on the questions that would get all fit together.

Echoes of this idea were also evident in the following response, but to a lesser extent.

TODD: Well, when I have learned something I will know because I will be able to form my own theories and also be able to explain it better to someone else.

Interview Question 3: *What happens if there are wrong things in the database?*

All students who were asked this question expressed a tolerance for notes that contained misconceptions. Most students seemed to view "wrong theories" as just an expected initial step in the process of trying to learn something.

NANCY: Wrong theories . . . I don't think there really is such a thing as a wrong theory, because I consider it that theories are just what somebody thinks. Theories . . . if there was wrong information you could correct it. But with theories I think that there isn't a wrong answer with theories because it is just what somebody thinks, and if it is wrong, then that is fine, because it is just a theory, it is just what somebody thought, and they are able to correct themselves by new information and things like that. So I don't really think that there could be a wrong theory.

MARGE: I think that wrong theories are okay because they are just what people think and they can be corrected. But if you put a right theory down, then you can just think to yourself, well maybe I am getting better at this because it is a right theory. But wrong theory, you think, okay, well that is fine, I have learned from it that it doesn't work this way, it works this way.

RUTH: Then you learn. Most theories aren't right. It is very rare that someone will get an exact theory. So if you get one that is wrong you just think, oh, well, gee! This is the way it works. And then you learn and you just revise your theory.

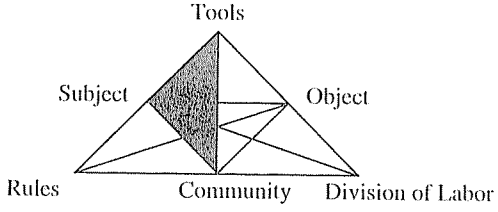
BILL: That is fine, because the theory isn't the information that they think. It isn't carved in stone or anything. You can always change what you think of a certain problem.

Common to most student responses was an implicit or explicit recognition that learning was an active process of improving one's understanding. Of course, it is difficult to know to what extent students had genuinely adopted that philosophy or whether they were simply saying what they thought the interviewer wanted to hear. However, there is a high level of consistency between the student interview responses, the way that students interacted with the teacher, and student actions in Knowledge Forum. Even if some students privately harbored doubts about the

classroom emphasis on progressive, collaborative sense-making, they at least seemed to have a rudimentary understanding of what it entailed.

Clearly, student attitudes about learning and their day-to-day practices in Knowledge Forum were largely a product of a knowledge building culture that the teacher fostered in his classroom. Knowledge Forum technology offered a medium through which learners could engage in knowledge building operations, but the students' sense of mutual trust, their priorities, and their tolerance for each other's ideas were largely forged through face-to-face processes.

Subject-Community-Tools: Design Supports for Knowledge Building



Knowledge Forum software was designed to support individuals and groups in their efforts to collaboratively advance knowledge. The principal tool for student interaction in this class was an experimental facility known as the "Discussion Note" or "Discussion Window" (Figure 8.4). The Discussion Window contained two parts: a small problem area at the top and a scrollable discourse area below. This arrangement allowed students to engage in lengthy discussions without losing sight of the core problem (Hewitt & Scardamalia, 1998).

The discussion facility was designed to focus students on the collective efforts of a group of people. Many computer conferencing environments (especially web-based environments) display the contents of each participant's note in its own individual window. In the discussion facility, the contents of the notes are displayed together in the same scrollable region. In fact, it is difficult (although not impossible) for students to view their contributions in isolation and out of context. Thus, this aspect of the software highlights the mission of the group rather than the performance of the individual. From an Activity System perspective, Knowledge Forum not only mediates the Subject's work with the Object, but it also amplifies communal goals and the Subject's perception of his or her role in the Community.

Knowledge Forum software also contains supports that relate directly to the teacher's instructions and the classroom protocols that he developed. To add a note to a Knowledge Forum discussion, learners click on the "Add" button at the bottom of the Discussion Window. Doing so produces a

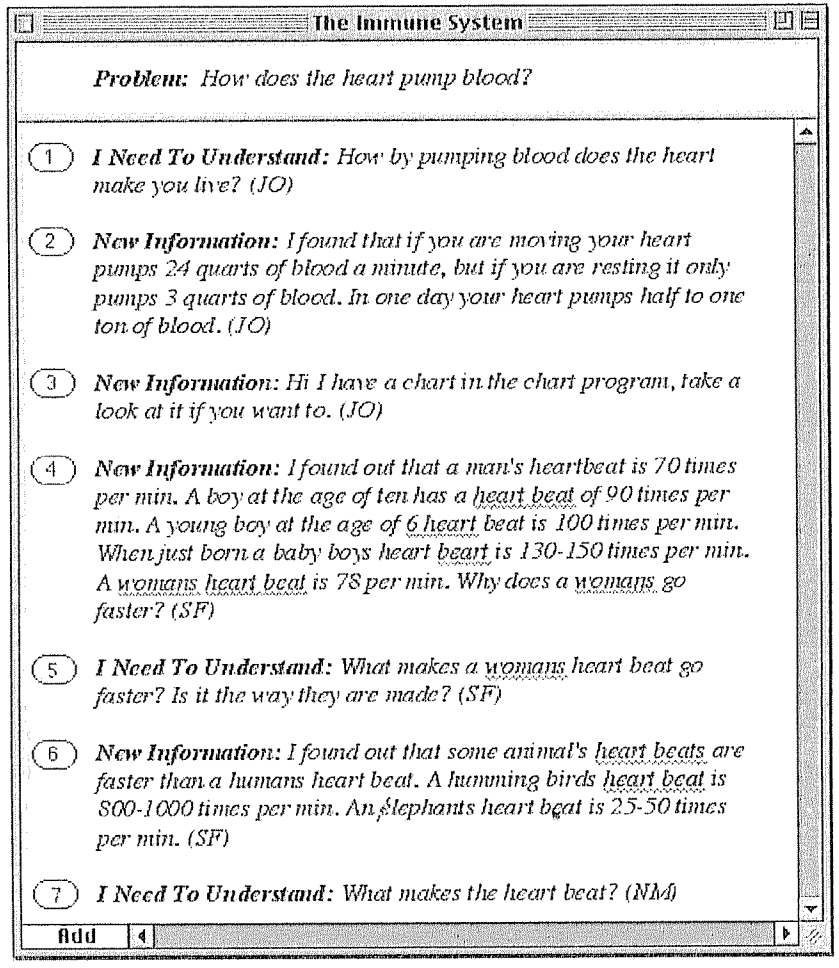


FIGURE 8.4. A Discussion Note window

pop-up list of scaffolds: My Theory, I Need To Understand, Comment, New Information, and What We Have Learned. Students must decide which scaffold best describes the contribution that they are planning to make. When the student's work is finally saved, the selected scaffold is displayed in boldface in front of the text.

The design of the Discussion Window emerged, in part, out of concerns about cognitive load. When Knowledge Forum is used without the discussion facility, each note is displayed in its own separate window, connected to another note by threads. To read an entire discussion, students must open a note, read its contents, identify the next note in the chain, open that note, read its contents, and so forth. While single-note threaded discussion interfaces are common in distance education circles, it was felt that they

could be problematic for elementary students. The need to constantly open, arrange, and close windows can interfere with learner efforts to follow a line of thought that spans many notes. Accordingly, the discussion facility was invented to minimize the effort required to review a discussion and keep students focused on a central problem statement. A comparative study of the single-note interface and the discussion interface revealed significant advantages in favor of the latter. Individuals using the discussion format responded to other people's notes more frequently, engaged in lengthier discussions, and were more likely to focus their work on the problems that they had set out. Students spent less time on window management, and more time focusing on the content of the investigation. In general, the discussion interface better matched the needs of a classroom community that valued progressive, collaborative knowledge advancement around specific problems of understanding.

DISCUSSION

The preceding analysis describes how the strength of this particular learning community emerged out of the multiple interrelated ways in which knowledge advancement was supported by the full sociocultural context of the classroom and the online environment. Learning was both an individual and a collective goal, and it was supported in numerous ways by the rules governing classroom behavior, the allocation of roles and responsibilities, and the design of the Knowledge Forum interface. Specifically, an examination of the Subject-Community relationship from four different perspectives yielded the following findings:

Subject-Community-Object

The goals and intentions of the Knowledge Forum classroom were unlike those of conventional classrooms. The teacher worked to foster a culture of collaborative knowledge building, one in which advancement of communal knowledge was the central objective. Knowledge Forum discussions (Object) made this process tangible (and achievable) by serving as an ongoing record of the community's investigations. By preserving discourse electronically, the work of the community became an object that could be studied and progressively improved upon. Thus, the Subject-Community relationship was conceptualized as one of mutually reinforcing growth: individuals learned from the online knowledge base of the collective, while simultaneously working to increase that knowledge base.

Subject-Community-Division of Labor

The Subject-Community relationship was also defined by the way in which responsibilities were divided in class. Within a particular unit (e.g., human

biology), different groups of students had different areas of expertise and each group contributed something new and meaningful to the collective. The teacher didn't directly participate in the online discourse. However, through his publication assessment technique he counseled students on their Knowledge Forum productions, encouraging them to work at the leading edge of their thinking and facilitating disequilibrium when the opportunity arose.

Subject-Community-Rules

A key element of any community involves the accepted protocols for interaction. A shared language is one part of that protocol (Lewis, 1997). For example, phrases like "My Theory," "New Information," and "I Need To Understand" were made a part of the classroom culture. Another part of the protocol involves how people are expected to interact with one another. During class meetings and in one-on-one situations, the teacher emphasized that each class member is expected to be tolerant of other people's conjectures and ideas. This outlook was reinforced by the teacher's own assessment scheme. For example, he frequently published student theories that contained incomplete or incorrect explanations. Interview data suggest that students accepted the notion that their initial theories were tentative and that they should work to improve them. Thus, the Subject-Community relationship was focused on building and sharing conjectures, identifying what is not understood, conducting research, respecting other people's beliefs, and working to continually improve upon what is known. The teacher forged this culture of mutual trust and respect in his day-to-day classroom interactions with students.

Subject-Community-Tools

The user interface of Discussion Notes was designed to emphasize communal discourse over individual productions. It was also designed to keep difficult problems in view, and to support, through scaffolds, the discourse of the classroom (e.g., "My Theory," "New Information," "I Need to Understand"). Thus, Knowledge Forum not only mediated the Subject's work on the Object, but it also reinforced the communal nature of the students' research endeavor and the established language protocols of the classroom. More specifically, the online environment contributed to a sense of community in the following ways:

- Access: The online environment transformed the intellectual resources of the community into tangible objects of inquiry.
- Amplification of Individual's Role in Community: The online environment amplified a sense of community by presenting individual work

within a communal context. Knowledge Forum emphasizes community artifacts over individual productions.
- Problem Focus: The online environment kept the pressing problems of the community in view.
- Language Support: The software scaffolds (e.g., My Theory) fostered the development of a specialized language – one used by the community both on and off Knowledge Forum.
- Mentoring Support: The teacher, in his meetings with individual students, used the online environment as an aid for mentoring students and better focusing them on communal artifacts.

What is striking from the preceding analysis is the intricate way in which the goal of knowledge construction was interwoven into both the online environment and the cultural fabric of the classroom community. It is unlikely that Knowledge Forum would have operated as effectively in a context that was less supportive of the students' expression of personal theories or of an inquiry-based approach. In the past, Knowledge Forum has occasionally been introduced into classrooms where the dominant cultural practices were inconsistent with the KBC model. The results were rarely positive. Sometimes Knowledge Forum was abandoned altogether. In other cases, the technology was used in unconventional ways to serve different goals. Such outcomes are consistent with findings that teachers often use educational software to sustain existing pedagogical practices rather than alter the way that they teach (Cuban, Kirkpatrick, & Peck, 2002). Knowledge Forum software, by itself, is unlikely to bring about significant change in the classroom. However, for teachers who are working to transform their practice, the technology makes possible new models of classroom learning that would otherwise be difficult or impossible to implement.

CONCLUSIONS

Sociocultural theory suggests that learning should be viewed as a process of increasing one's participation in communal practices (Lave & Wenger, 1991). This perspective provides researchers with a powerful theoretical lens for thinking about educational processes. However, for the purposes of educational reform, sociocultural theory is frustratingly vague. While communal participation may be a necessary condition for individual growth, it is not a sufficient one. The pressing questions for educators are "What kind of community?" and "What kind of participation?" These questions become even more urgent when viewed in light of recent advances in electronic communication. Networked technologies now allow communities to be connected in entirely new ways.

As researchers explore the possibilities that new technologies offer, it is important to remember that community building is a difficult process,

and there are some aspects of community that technology simply does not support very well. For example, trust is a key part of teamwork, yet trust is difficult to establish through electronic communication (Kling & Courtright, this volume; Vaillancourt, 2002). In the grade 5–6 Knowledge Forum classroom, students were willing to publicly post their (often erroneous) theories because the teacher had fostered an atmosphere of mutual trust and tolerance for tentative understandings. It is highly unlikely that this level of trust could have developed through online interaction alone.

In some respects, an expression like *virtual community* may not be particularly useful for educational research. Fundamentally, it is a technocentric phrase that says nothing about educational rationale or purpose.[1] Instead, it conjures up images of a community in which relationships and interactions are completely circumscribed by an electronic medium. As already discussed, such a community may be difficult to develop. Some of the more compelling computer-assisted communities include ones in which subsets of community members occasionally meet face-to-face (e.g., Barab et al., this volume; Derry, Seymour, Steinkuehler, Lee, & Siegel, this volume; Schlager & Fusco, this volume). Nor is it unusual for users of online environments to be colleagues from the same institution, or students from the same class (e.g., Bruckman, this volume). The problem with the word "virtual" is that it de-emphasizes and devalues any face-to-face communication that might be taking place behind the scenes – even though these conversations may be contributing to the development of community.

Arguably, if one's overarching research goal is to design educationally effective communities, then the expression virtual community is unnecessarily constraining. Most real-world communities do not confine their constituents to a single mode of communication. Instead, people benefit from the ability to interact with one another in a rich variety of ways (e.g., face-to-face discussion, paper, telephone, fax, email, computer conferencing). In the same fashion, educational communities should ideally be designed to exploit synergies across different communication modalities.

This chapter's Activity System analysis of a classroom-based KBC describes an innovative way in which computer-based and classroom-based processes can be combined to forge a new kind of learning community. Within this classroom model, students purposefully carry out investigations of their own design. This chapter described how different elements of the community – objectives, rules, language – were distributed across face-to-face and online contexts, reinforcing one another. The result is a culture that is quite unlike that of traditional classrooms. In a regular class, questions, theories, ideas, and discussions are personal, ethereal constructs. In a KBC classroom, they are public artifacts that have a permanent

[1] The phrase *virtual community* stands in stark contrast to phrases that describe principled educational models, such as *community of learners* or *Knowledge Building Community*.

presence in the classroom database. As such, they can be analyzed, pointed at, talked about, and progressively refined over time. Knowledge Forum technology supports a new approach to classroom learning, one that focuses learners directly on the process of knowledge production. This ability to support previously undreamed of community models may be one of the more important educational dividends of networked technologies.

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