From Ambitious Vision to Partially Satisfying Reality: An Evolving Socio-Technical Design Supporting Community and Collaborative Learning in Teacher Education

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Introduction

Our chapter relates to an ongoing and continuously evolving research and development project that has as its goal the design of a socio-technical system (a technical environment and related social structures and activities) that will constitute a good model for distributed teacher professional development programs conceptualized as knowledge-building communities. We focus primarily on a part of our work that is situated within the Secondary Teacher Education Program at the University of Wisconsin-Madison. We begin by describing the original ambitious vision for this program that we set out to implement, including its theoretical basis. Then we discuss how both our initial failures and the theoretical framework itself led us to more carefully consider how the historical and institutional contexts of such community-building efforts might influence the social processes of learning and teaching within the community. To illuminate this idea, we present a contextual analysis of the program as a prelude to an interaction analysis of a representative discourse from a group learning activity within the program. Throughout our chapter, we consider lessons learned from studies such as these and from our immersion in the experience of designing a socio-technical environment for supporting community-based teacher education. Drawing on these lessons, we describe our modified goal and the latest results of our efforts to develop an online system for structuring and supporting group learning, including the online mentoring of such learning, within teacher education programs.

Original Vision

Previous work on building learning communities has produced fruitful results. Research demonstrates that collaboration, experimentation, and challenging discourse must be encouraged in order for teacher learning communities to succeed (Little, 1993; Norris, 1994). "Challenging discussions are not very common among teachers, who often equate criticism with personal inadequacies" (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Yet a professional culture necessitates the analyzing, explaining of evidence and communicating criticisms in order to learn. What we advocate for students, teachers need to learn as well (Loucks-Horsley, et al., 1998). Reforms in education are often fundamentally flawed because they do not attempt to alter the structure of classroom discourse (Sarason, 1996). Studies find that using computer support for collaborative learning can drive changes in teacher practices from didactic to constructivist (Henze, Nejdl, & Wolpers, 1999; Resta, Christal, Ferneding, & Puthoff, 1999). A shared mission, continuous improvement, and results orientation are also important for professional learning communities to thrive (DuFour & Eaker, 1998).

Accordingly, our original vision for the Secondary Teacher Education Project (STEP) was to develop a technology-based distributed professional learning community as a model for teacher education. We wanted to design a learning environment that integrated academic coursework and practice in schools through collaborative instructional design projects carried out by teams composed of teacher education majors, university faculty, and classroom teachers from local area schools. Teams were to be student centered and include professional mentors from university faculty and area schools. Through participation on teams, members of the community would examine their beliefs about schooling in light of current science, educational theory, and authentic school contexts. This professional learning community would construct and reconstruct knowledge about teaching and learning in classrooms. Because teams would be geographically dispersed, online synchronous forums would be used to support collaborative work that could not feasibly take place without them. Also, collaborative projects would produce artifacts, such as model lessons, constituting an evolving base of instructional "cases." A case-based web technology would be developed to support maintenance of this communal knowledge base, as well as access and use of it for collaborative teaching and learning. That was the ambitious vision written in a proposal to NSF in 1998. Three years later we examine what STEP is now, where it is headed, and how and why the project's original vision changed.

The Knowledge Building Community Framework

Both the original and evolving visions of STEP have been informed by the Knowledge Building Community (KBC) Framework (see Figure 1), a perspective that focused us, as designers, on supporting group and community interactional processes, on considering how social and historical contexts might shape such interactions, and on the evolution of knowledge and beliefs at both the individual and community level (Derry, Gance, Gance & Schlager, 2000; Hewitt, this volume; Riel & Polin, this volume). The KBC Framework represents a synthesis of four theoretical viewpoints regarding the nature of social knowledge construction: sociocultural/situative, sociocognitive, argumentative, and group information processing. The constructs we borrowed from these views and fused in our framework are briefly described below.

Sociocultural/Situative Perspective. A sociocultural/situative viewpoint (Greeno, 1998; Wertsch, 1991) dominates this framework. From this view, knowledge construction involves work activity, a process through which key "boundary constructs" (e.g., Wenger, 1990) evolve into mutually understood "new" ideas, behavioral norms, and other intangible constructs that shape and are shaped by teamwork. Boundary constructs are ideas brought to the work initially by members of diverse backgrounds, and are so named because they represent shared general ideas within overlapping boundaries of disciplinary knowledge. Documentation that boundary constructs emerge and evolve into shared concepts that drive and support group work is evidence that a knowledge-construction system is operating. Sociocultural/situative theory implies that processes of negotiation and apprenticeship drive such knowledge construction. Hence, presence, frequency, and quality of these processes within work groups dictate and indicate how well a group or community functions as a knowledge-construction system. This viewpoint led us, as designers, to consider such issues as attracting or selecting members for diversity and overlapping knowledge boundaries, and creating a system to support and facilitate collaboration, viewed as negotiation, apprenticeship and mentoring.

Sociocogitive Perspective. Figure 1 also represents a sociocognitive perspective, so named because it views knowledge construction as an individual cognitive activity driven by social interaction. Knowledge construction is seen as involving changes and realignments in individuals' mental representations of their work. Theoretically, as community members collaborate, their individual mental models of group tasks, community constructs, and the community itself become more aligned with one another. Some degree of mental-model alignment is considered a necessary precondition for productive work, although some misalignment is desirable (e.g., DuRussell & Derry, in press; Orasanu & Salas, 1993; O'Donnell et al., 1997). When people with different points of view work together, their interactions produce cognitive conflicts that individuals seek to resolve through argumentation, theoretically driving conceptual change. Hence, from the sociocognitive perspective, communities are operating as knowledge construction systems if there is evidence of conceptual and belief change within individuals and a trend toward increasing compatibility among members' task-related viewpoints. Like the situative/sociocultural view, this perspective also focused us, as designers, on constituting groups with members having diverse but overlapping systems of knowledge and belief. In addition, this view encouraged design of activities that create some cognitive conflict but that embed within them mentoring processes that manage this conflict toward desired learning goals.

Argumentation Perspective. The KBC model also incorporates a literature that views knowledge construction as both process and product of argumentation and informal scientific reasoning. This "critical thinking" (e.g., Halpern, 1996; Kuhn, 1991) viewpoint suggests that such processes as negotiation, apprenticeship/mentoring, and conflict resolution be judged against established standards for argument form and content, recognizing that argument in conversation is ill-structured and both temporally and socially distributed (Resnick et al., 1991). It suggests that the knowledge resulting from valid argument is superior to knowledge resulting from less logical processes. It suggests that "respect for good argument" should be a social norm that is promoted and supported within the community (Hewitt, this volume). The degree of adherence to critical thinking norms can theoretically be detected in transcripts of conversation and reports of individual beliefs. As well, individual and group products can be assessed on whether judgments and decisions are based on evidence and valid argument (cf., Bell & Linn, 2000; Ranney, Adams, Siegel & Brem, 1999; Siegel, 1999; Siegel & Lee, 2001; Watson, Swain, & McRobbie, 2001). Recognizing that valid argument in instructional conversation may be infrequent and difficult to promote (e.g., Derry, Gance, & Gance, 2000), as designers we saw the need for system design that would scaffold good argumentation within the community's learning and working groups.

Group Information Processing. Finally, Figure 1 incorporates group information processing theory (Hinz, Tindale & Vollrath, 1997; Smith, 1994). From this view, the potential for knowledge construction depends on such interacting factors as the: 1. Available knowledge within working groups; 2. Extent to which shared knowledge overlaps among group members; 3. Processes by which information is shared among members, and 4. Stages by which information is transformed from one form (e.g., private, shared/unshared knowledge) to another (e.g., a tangible group product). As designers we were encouraged by this view to attend to the constructing of a system with affordances and constraints that shape these group information-processing factors. These include social factors, such as status of individual members and their group allegiances. For example, desirable group characteristics include moderate cultural/professional diversity (broad knowledge capacity with an overlapping base for starting communication) accompanied by high levels of information sharing among all social categories (broad knowledge distribution). Other factors shaping group information processing include behaviors and contexts that impact important information processing phases, such as the attentional phase. For example, environmental events (e.g., overlapping talk, distracting noise) that interfere with information sharing and inhibit group work must be minimized by socio-technical designs. Also, working groups must be supported in effective processes of transforming talk (planning, thinking, analysis) into the final required products that will be evaluated.

We have found the theories outlined above to be commensurate and overlapping in important ways. Briefly, the situative/sociocultural, sociocognitive, and group information processing viewpoints focused our design team on issues pertaining to membership, such as populating the community and constituting work groups with diverse but overlapping systems of knowledge and belief. All four views required us to consider how to support and manage the knowledge construction processes whereby these systems interact. These processes are: negotiation, apprenticeship/mentoring, resolution of cognitive conflict, argument, and information sharing. Although these processes are named and conceptualized differently across theories, their boundaries and definitions overlap, and we adopt the view that knowledge construction can and should engage all these forms of interaction. Hence, one of our design goals has been to promote and manage these types of interaction. We have also been concerned with supporting stages of information processing, such as group attention, by creating environments that minimize overlapping talk and other distractions, such as technology difficulties. Finally the information processing aspect of the KBC model has prompted us to consider the importance of tools and procedures for helping work groups translate their discussions into tangible products, such as designs for classroom instruction.

However, perhaps the most critical aspect of the KBC model, for purposes of guiding program design, is its overall unified nature. The KBC model is a complex system requiring certain forms of communication, joint work, artifact use, and processes of membership renewal, all operating in synchrony. Thus a KBC cannot exist without “buy-in” from many constituents. And because the ability to achieve such buy-in is largely determined by the historical, institutional, and social contexts of the system-design project, these will be examined next.

The Secondary Teacher Education Program as a Context for Design

The context in which much of our design work is taking place is the secondary teacher education program at UW-Madison. It is a grade 6-12 certification program at the baccalaureate level involving five broad majors: mathematics, science, foreign languages, English, and social studies. Students usually enter the program in their junior or senior year or beyond, after completing coursework in their academic majors. The program is four semesters long and integrates eight methods and foundations courses with field experiences and student teaching. The program is relatively new and is still evolving. Program faculty from multiple departments try to meet monthly and strive for both vertical (between semester) and horizontal (within semester) integration across courses and field experiences. The program vision shared by faculty and promoted to students when they enter is one of an evolving knowledge-building community that includes university faculty and staff, the teacher education students, and teachers in cooperating schools.

In this paper we examine the program from the perspective of third-semester instructional staff in charge of a foundations course in the learning sciences that is horizontally integrated with courses on literacy and diversity and a practicum field experience in local schools, and vertically integrated with methods courses and student teaching in the five certification areas. Our role within the program has involved viewing and influencing design of the program as a socio-technical learning community, with funded research obtained by the first author in support of this endeavor.

There are many positive forces operating within the program that support and encourage development and evolution of the socio-technical learning community vision. In the constraint category, legal credentialing requirements imposed by the state legislature and Department of Public Instruction have had the positive benefit of forcing busy faculty from different departments to come together to write standards for the new program and coordinate their courses and syllabi in working toward standards. Additional constraints include scarcity of staffing resources, practical limits on faculty and student time, as well as travel requirements associated with participation in and supervision of field experiences, including urban and foreign field experiences, which together encourage development and appreciation of online courses and meetings as alternatives to face-to-face interaction. In the category of positive affordances, the faculty and institution are collegial, supportive, and have proved willing to tolerate risks associated with innovative instructional programming.

Despite this necessary and positive context, we have also experienced numerous problems and resistances to developing the socio-technical learning community originally envisioned. In conceptualizing these resistances, we have found Wertsch's concept of "voice" (e.g., 1991) to be helpful in describing the program in terms of overlapping sub-discourses that do not easily interact in accordance with the KBC framework. These voices represent concerns and belief systems that are sometimes in conflict. They include various academic disciplines and epistemologies represented in the program; the cooperating school personnel, principally teachers, who interact with the program; the university administrators concerned with meeting accreditation and certification requirements; university faculty and instructional staff who teach and supervise program students; and the pre-service teachers who are students in the program.

An important and influential voice within the program is that of the university staff, including administrative program heads, administrative support personnel, teaching faculty, lecturers, field supervisors, and teaching assistants. Many of these staff members are graduate students. While these constituents do not always agree or speak with one voice, they meet regularly, tend to reach decisions cooperatively and collegially, and generally support one another as members of a team. However, there is substantial turnover in this group from semester to semester, and the group is scattered among offices in several buildings. While there are several long-term core members, the responsibilities of instructional staff often shift from semester to semester. Because time constraints are substantial, many participate extensively only during meetings and semesters that most directly relate to their specific areas of responsibility, and communication between meetings is relatively limited. One difficulty for the instructional staff is moving from newcomer status to old-timer status because of the shifting group structure; another is sufficient collaborative interaction. While this group has some degree of communal cohesiveness, it is loosely connected.

Another critical but currently even less cohesive part of the evolving community is the group of cooperating teachers who mentor students' field experiences. This group is geographically dispersed and never meets as a group, and its primary contact with the program are through the individual student teachers who work in classrooms and the program's field supervisors for these students. Through indirect communication with field supervisors and students, program faculty who teach university courses strive to help coordinate their students' course-related field assignment with cooperating teachers' needs and constraints in mind.

By contrast, student cohorts seem more tightly connected. The program admits one or two cohorts per year that range in size from about 65 to 25 students. These students are assembled into three interdisciplinary learning communities (to promote the KBC goals of interaction among overlapping knowledge bases and systems of belief) that take courses and are assigned field placements together during the two-year program. In addition, the entire cohort meets on a regular basis. Students seem to quickly cohere and form relationships. They sometimes organize to make their wishes known and can function effectively as a political "bloc."

Many instructional staff work intensely with cohorts for only one semester. This is the case for our psychological foundations instructional staff, which encounters a cohort only after it has been together for a year. And while there are only a few instructional staff during the third semester, there are a great many students. Thus the semester begins with allegiances reflecting an in-group/out-group structure, with instructional staff on the "outside." Such structural asymmetries in group composition tend to create comparable asymmetries in group interaction, such that in-group members dominate conversation and tend to share and impose common knowledge and belief systems (e.g., O'Donnell, DuRussell, & Derry, 1998).

Goals of pre-service teachers are often in conflict with those of faculty and other instructional staff in schools of education. For example, our instructional staff expects students to acquire in-depth understanding of learning science concepts and learn to flexibly apply these concepts to the analysis and design of learning environments. Whereas an important goal for some students is to develop such knowledge and ability, many want other competing things from their teacher education program, such as rapid career entry, efficient credentialing, and specific instructional methods and materials. This tension between supporting immediate needs and facilitating more general professional development is described elsewhere as well (Barab, MaKinster, & Scheckler, this volume; Kling & Courtright, this volume). This ability of a socio-technical system to meet the immediate instructional needs of the users of the system, may account, in part, for the success of the Math Forum (Shumar & Renninger, this volume).

The instructional staff asks students in the program to engage with a variety of unfamiliar theories and concepts and to use these in helping reformulate their practices and vision for education. Simon (1992) characterized this as a fear-provoking situation. He believes the sources of such fear are legitimate and include students' feelings of marginalization due to lack of facility with a new discourse they are being asked to acquire. They include realizations of the time commitment involved and resistance to examining and possibly abandoning currently held values and practices. Hence the voices of the students sometimes reflect impatience, resistance, perhaps even fear, toward theoretical material they are expected to learn.

Further, research on collaborative learning has repeatedly documented the effects of status on individual student experiences within groups. For example, high-status group members tend to gain and maintain group attention; they talk more, and they derive greater learning benefits from group interaction. Lower-status group members are often marginalized and discouraged from participating (O'Donnell et al., 1997; O'Donnell & King, 2000). Of course individual personality matters greatly and students do not always conform to expectations based on group norms. Nevertheless, we believe that many group-membership characteristics that affect status are inherently present within the UW secondary teacher education program. For example, like Tannen (1990), we observe conversational styles associated with gender, whereby males seem more aloof and/or communicate for the purpose of providing information or gaining status, while females seem more concerned with affiliation and maintaining community relationships. Moreover, the program is multi-disciplinary, with different academic disciplines holding different ranks associated with status in the university community. For example, physical scientists are generally regarded with higher status than are social scientists (O'Donnell et al., 1997). So, for example, if a group comprises several male scientists and one female social scientist, it is likely that the female social scientist will be marginalized in group interaction.

It was with these social contexts in mind that we began to examine social processes within the newly developing program, trying to gain a better understanding of what kinds of interactions our socio-technical design must mediate (e.g., Derry, Seymour, Feltovich, & Fassnacht, 2001; Siegel & Lee, 2001; Steinkuehler, 2001). So far our work has concentrated largely on trying to understand the interactions among the teacher education majors and the graduate-student instructional staff in our learning sciences course, in which TA's supervise small group learning activities, including extended projects. In the following we spotlight one analysis of a short segment of face-to-face classroom discourse that we believe is characteristic of such small-group instructional interactions. The analysis was conducted at a time when the program was just beginning to incorporate technology in various ways, but was not yet offering online instruction. A discussion of how such analyses influenced design of the online system, which we believe mediates and improves those interactions and promotes community, will follow.

A Study of Collaboration Within the Program

The forces of resistance described above are clearly present and influential within the collaborative interactions that take place in program classrooms. How these conflicts were manifest within the science education program during spring semester, 2000, are illustrated through an analysis of a videotape of an instructional discussion that took place within the 3rd semester psychological foundations (learning sciences) course. This course is designed to help future teachers develop a scientific stance toward learning and development that can be used as a basis for analyzing classroom practice. A goal of this ongoing course is to help future educators develop a respectful, self-critical, scientific stance toward their own and others' classroom practice, as a basis for continuing professional development and improving instructional designs. A typical assignment in this course may require several weeks to complete. A representative assignment is one in which small group of student teachers works with a teaching assistant to apply learning sciences concepts in critiquing a case of actual classroom teaching, and in justifying a redesign or adaptation of the example lesson given in the case.

This method of problem-based learning (PBL) was developed for medical education (e.g., Barrows 1989) and has spread to many other types of classrooms, including K-12 classrooms. Elsewhere (Derry & the STEP Team, in press) we have described the purpose of PBL as helping students acquire domain knowledge, usually scientific knowledge, in the context of solving a real-world problem that is based on a real-world case. Our knowledge of this method is largely gleaned from wisdom of practice, from writings by its developer, Howard Barrows, and from the widespread PBL community that uses this method and has begun to conduct research on it. There are standard steps in PBL instruction, and many users of the method feel strongly that they work well and shouldn't be modified. PBL takes students through a facilitated small-group process in which students discuss and "solve" a problem case (e.g., a case of medical diagnosis) as they fill in labeled columns on a "whiteboard" (often a giant post-it note) that has been structured to guide discussion and thinking. In completing the whiteboard, students proceed through steps in which they notice facts about the case, formulate hypotheses, identify learning issues for further investigation, conduct research, and revisit and discuss hypotheses until a problem solution is reached. The main purpose of this activity is to learn about a conceptual domain as that conceptual domain is "shaped" and restructured in the context of realistic problem solving.

Here we examine a small segment of discussion that took place within a group of five science education majors who spent four weeks in a PBL activity, studying and redesigning a teacher's videotaped science lesson on static electricity. The case assigned to this group of science majors was "Students Get a Charge out of Static Electricity." The case materials were obtained from the STEP (Secondary Teacher Education Project) Web site, http://eSTEPWeb.org , which has been developed to provide access to instructional resources to support case-based and problem-based teacher education in the learning sciences. This case includes readings, videos, and inquiry materials, and tells the story of an actual science unit in a public school taught by a popular teacher and representing good traditional instruction. The group's instructional task was to advise Mr. Johnson (the teacher) on how to improve the unit and to justify the group's redesign in learning-sciences language. One solution that students could propose is to redesign the lesson as a more authentic, inquiry-based unit.

As is typical within this course, a relatively inexperienced teaching assistant served as facilitator for this discussion group. In PBL terms, such facilitators are typically called "tutors." This teaching assistant had received two days of training in a PBL tutoring workshop, conducted by an expert PBL teacher. In accordance with this method, the tutor guided her group through a series of steps that included identifying learning issues—things students needed to learn more about in order to solve the redesign problem. Between classes, students researched assigned learning issues (a process facilitated by the STEP web site), bringing varied findings to their group discussions.

Method

To examine classroom discourse, we employed an analytical approach known as *interaction analysis*, an interdisciplinary approach for investigating the interaction of people with each other and with their environment (Jordan & Henderson, 1995). This paper reports an interdisciplinary interaction-analysis team's observations of a two-minute segment of video recorded on the first day of the students' four-week PBL exercise. This segment was chosen by the team as a case representing cognitive and social conflict within a PBL group. A detailed transcription of the segment was prepared using traditional Jeffersonian notation (Atkinson & Heritage, 1984).

Analysis Participants. This segment has been analyzed by two groups, the first one at the University of Wisconsin-Madison. Analysts in this group included two professors of cognitive science, one a specialist in medical education and the PBL method, the other the first author of this paper and the developer of the subject course. Another participant was a specialist in medical education and PBL with advanced coursework in educational psychology. Seven graduate students in education and one education and research technology specialist with advanced training in conversation analysis (who facilitated the session) also participated in the analysis session. Five of these graduate students had been PBL tutors for the course, and one was the tutor being viewed in the videotape. The second interaction analysis session took place at Southern Illinois University-Carbondale. The same professors and medical education specialist took part. In addition, four additional professors – a conversation analyst (who facilitated the group), a science educator, a cognitive scientist specializing in collaborative learning, and a history professor developing an undergraduate PBL curriculum – took part. Nine graduate students in various social science fields and with no connection to the course also participated.

Data Analysis. In the first analysis session, the video segment was viewed without any comments three times. During this time the analysts made notes on their transcripts. At the end of the third viewing, the analysts wrote about what they had observed for approximately 10 minutes. Then, each analyst in turn explained his or her analysis of the video segment without comment by others. This was followed by a general discussion of various analyses. The session was videotaped, and audiotaped. Participating analysts' notes were also collected as a record of the analysis. In the second analysis session, the video segment was viewed repeatedly and discussed. The first author took detailed notes of the session. All recordings and notes were studied and synthesized by the first author of this paper, with other authors contributing feedback and revisions. The following represents an attempt to synthesize and capture the analysts' collective viewpoint regarding the selected video segment.

Results

The two-minute segment that follows is a small portion of a discussion that occurred over several weeks of class in which five student teachers, Dean, Bo, Cindy, Paula and Lou, led by their tutor, Janice, applied learning science concepts to the analysis and improvement of a high school static electricity lesson presented to them as a video case. The analysis of this segment is developed in four parts labeled: I. The memory incident; II. Lightning as a vehicle for teaching static electricity; III. Think in my terms; and IV. The Conflict. The discourse in segment I is course-term banter pertaining to one student's effort to recall a concern she had about the lesson. In segment II, this student recalls that her concern is about connecting the lesson topic to things students might know and care about, which leads to a discussion of whether lightning would be a good vehicle for presenting the topic. In segment III, the tutor attempts to have the students translate the discussion into course terminology and reinforces one student for naming a correct term. In segment IV, the dominant student in the group challenges the use of this term, drawing support from another student and creating the stage for escalation of a conflict.

The group of analysts, including the tutor, unanimously agreed that this segment was largely a story of conflict between the female tutor ("Janice") and a dominant male student, "Dean." All agreed the conflict negatively impacted the group and interfered with collaborative learning. During multiple sessions, analysts reflectively examined the discourse of the conflict in detail, developed informed hypotheses about its history and causes, and considered how a tutor might intervene (or how a system might be designed) to manage such conflict. The segmented transcript and a summary analysis of each segment are given next.

I. The Memory Incident

The PBL format is requiring students to generate and write on a whiteboard ideas for improving the instruction they are analyzing. The segment begins when Cindy has an idea for improvement but suddenly loses it from memory. This display provides Dean an opportunity to poke fun at course terminology. The tutor's response, line 7, appears to serve multiple functions. It corrects, builds relations among course terms, allows her to join in a joke with the cohort, and reprimands Dean for his resistance to terminology.

1. (15:53) CINDY: OKAY I HAVE A THING. Where did it go . . . to change.
2. (15:57) JANICE: Okay.
3. (15:57) CINDY: Um. (hands to head) Now I just lost it. Oh! Okay I'll- it'll all come back to me.
4. (16:02) DEAN: Ah did you lose it in your, working memory or your long term or your SENSORY memory (layering his arms for emphasis)?
5. (16:05) CINDY: Yeah I JUST thought of it and then I lost it.

6. (16:08) CINDY: Shoot.
7. (16:09) JANICE: Let her try to recall it from the long term memory back into the short term or working memory.
8. (16:12) PAULA: Um hm (chuckling)
9. (16:13) DEAN: Okay.

II. Lightning as a Vehicle for Teaching Static Electricity

II.1 Introducing the Topic and Preparing for Discussion. The next portion of the transcript begins with Cindy's gaining the group's attention and presenting her issue—that the instruction is not connected to real-world experience. This reveals her belief that teaching should help students relate science to life experience. The tutor supports the direction of Cindy's thinking and the group's excitement (with an approving nod). That Dean agrees and values Cindy's comment is indicated by his eagerness to get it on the board. Dean's gestures, intonation and volume suggest that he is taking a directive role of authority, while the tutor seems to follow his direction in preparing the board:

10. (16:15) CINDY: OH. How does this apply to like what the:y're . . . WHO cares. ? (Laughs, JANICE nodding)) I- Like if you're sitting here who cares they're going to be like great. I'm going to poke Paula and she's getting a shock who cares. What, his this going to help them in the real world kind of . . .
11. (16:29) DEAN: Okay, let's- where is it?
12. (16:30) CINDY: That would be my thing to change.
13. (16:32) JANICE: Okay, (inaudible) for you (She changes a part of the whiteboard)

II.2 Discussion of Lightning. With the board prepared for writing, Dean indicates that he has an idea. However, the group does not attend to Dean. Rather, in talk that overlaps with Cindy's continued expression of belief that science instruction should be connected to real-world issues, Bo makes a suggestion that lightning would be a good basis for teaching static electricity. In line 19, Cindy responds positively to Bo, sharing her pleasure at having learned something interesting about lightning. Dean corrects Cindy (line 20) as though she has expressed a misconception. The tutor sees in this discussion an opportunity to make a connection to a course concept and attempts to encourage the group to conceptualize the idea as such by asking in line 21, "What would I call that?" The tutor's question is part of much overlapping talk and is not attended by the group. This segment ends with Cindy's resorting to gesture to overcome overlapping talk and communicate to Dean that she is not misinformed.

14.	(16:35) DEAN:	Well I have an example of how does this help in the real world.
15.	(16:38) BO:	Sort of like how does, how does . . .
16.	(16:38) CINDY:	Okay but they don't see how . . . THEY'RE not getting that.
17.	(16:41) BO:	How does how does like, something they see everyday like lightning, how does how does that . . .
18.	(16:42):	Various students talk
19.	(16:44) CINDY:	Okay which actually, comes from the ground. (laughing) I was really pleased when I learned that.
20.	(16:46) DEAN:	Well actually it comes from both.
21.	(16:48) JANICE:	What would, what would I call that?
22.	(16:48)CINDY:	Well I mean like people think . . . (she motions with her hands)

II.3. Owning and Developing the Lightning Idea. Dean opens the next phase of talk by using intonation and gesture to "proclaim" that the lightning idea is an amazing one, appearing at once to both "own" the idea and grant Cindy (not Bo) credit for it. In line 24 Bo meekly indicates that Dean is reiterating his thinking. Dean continues to proffer the lightning idea and think out loud about it, using tone and gesture in ways that suggest he is stating new information, although he is largely reiterating and confirming what Cindy and Bo have attempted to express. His statements reveal something about his teaching philosophy, that instruction should begin with topics familiar to students. It is clear that Dean, Bo, and Cindy are in basic agreement about the use of lightning as a basis for redesigning the static electricity unit:

23.	(16:49) DEAN:	(gesturing towards CINDY) Now LIGHTNING, would be an AMAZING way for them to talk about static electricity.
24.	(16:54) BO:	That's what I was thinking.

25. (16:54) DEAN: Because, that's a great idea because they all know, about lightning. They've seen it, But I don't think

26. (16:59) CINDY: But you know what?

27. (CINDY pointing with pen at table)

28. (17:00) DEAN: I don't think they even realize it's static electricity.

29. (17:01) CINDY: EXACTLY because they're talking about putting, electrons here, and there's no reference to what, they do in the world . . .

III. Think in My Terms

In the following segment, the tutor (line 30) begins by asking the group to conceptualize the discussion in learning sciences terms by asking, "What would I call that?" Although Cindy immediately responds with the desired term (authentic learning), this response is masked by Dean's overlapping response to the tutor in line 33 expressed in a very sarcastic tone, "I've no idea what YOU would call that . . ." Cindy then repeats her answer (authentic learning) audibly, which the tutor enthusiastically reinforces as "correct." Cindy responds to the tutor's reinforcement with obvious joy and delight. Dean's responses in lines 37 and 39 can be viewed as attempts to dismiss the topic as something irrelevant that they have already discussed. Paula's turn is likely a suggestion to put Cindy's term on the whiteboard. It seems significant also that in lines 32, 35, and 38, Cindy gradually changes the referent term so that "authentic learning" first becomes "authentic learning application," and finally "authentic instruction."

30. (17:06) JANICE So what- so what would I call that?

31. (17:09) PAULA: (inaudible)

32. (17:09) CINDY: authentic learning

33. (17:09) DEAN: I have no idea what you would call it to be honest.

34. (17:11) PAULA: (inaudible) . . . better than I am.

35. (17:12) CINDY: Is it authentic learning application?

36. (17:13) JANICE: YES! (throwing her head back to look at CINDY who starts to laugh)

37. (17:15) DEAN: Oh yeah we, we talked ALL about that last time. (CINDY laughing and raising arms)

38. (17:19) CINDY: Okay it's authentic instruction.

39. (17:20) DEAN: We were all over that.

40. (17:21) PAULA: So put . . .

IV. The Conflict

IV.1 The Assignment In the next segment, Dean questions whether using lightning to teach static electricity should be labeled as authentic instruction. Although he might be trying to recover from some lost status due to another students' being reinforced for naming the correct term when he did not, this was also a legitimate question. The tutor responded by suggesting that Dean make authentic instruction his learning issue (meaning investigate the term further). In line 45, Dean responds to this assignment with incredulity and an argument erupts in which the tutor repeatedly insists he conduct the research and Dean protests that he has already read and re-read material on the WWW. Paula supports Dean in lines 47 and 49, indicating that she feels the assignment is unreasonable.

43. (17:22) DEAN: But, talk about lightning (I think) that's authentic? (pause) See I wouldn't have thought about that as authentic instruction.
44. (17:28) JANICE: I think that that needs to be YOUR (indicating DEAN with her pen) learning issue then.
45. (17:32) DEAN: WHAT? (dropping pen on table)
46. (17:33) JANICE: I need you, I think you need to investigate authentic learning?
47. (17:36) PAULA: Aw . . .
48. (17:36) DEAN: I've looked on the web like NINE times.
49. (17:38) PAULA: Yeah.
50. (17:38) JANICE: Can you look somewhere else, can you try to think about why, ah?

IV.2. The Face-off. In lines 51-53 Paula and Dean offer a joint argument that authentic instruction is not teaching science using real-world examples, but teaching through a process that involves real-world activity. Cindy begins to reconcile the two ideas, noting that authentic instruction refers to both. However, the tutor cuts her off in responding to Dean. Noting the tutor's emphasis, pausing and tone, the analysts concluded that the tutor's response was a reprimand. Noting the non-verbal gestures between Dean and the tutor, one analyst described the scene as "dueling rams." Dean grudgingly concedes, capitulating to the tutor as a way of ending debate rather than agree. Following an awkward pause, Bo diffuses the situation with a humorous comment.

51.	(17:42) DEAN:	Well because they're not, going to do . . .
52.	(17:43) PAULA:	That's not an authentic method that's just, something that happens that they've seen is what he's saying.
53.	(17:47) DEAN:	Is that what makes it authentic instr- because my understanding of authentic instruction, it's doing things that REAL people, in the REAL world, would do.
54.	(17:53) CINDY:	Oh, I think it's both.
55.	(17:55) JANICE:	So, would REAL people, in the REAL world, LOOK at lightning, and NOT know, what it was!? And would they WOnder. And would it HELP them in any way, to understand, weather, or electricity?
56.		(long silent pause)
57.	(18:10) DEAN:	Yes.
58.		(silent pause)
59.	(18:13) BO:	It would help them to know that if they have a [*brushing head with hand*] whole bunch of electrodes in their head they should go somewhere else.

Perhaps, all's well that ends well. Immediately after this PBL session the tutor requested a private meeting with Dean, the dominant student. Dean confessed that out of frustration with his previous tutor's lack of guidance during PBL sessions, he was used to taking control. Janice expressed her determination to help Dean see that PBL could be worthwhile, which she believed could be accomplished by providing more structure to the PBL process than Dean had previously encountered. Janice and Dean left the meeting agreeing to work together to include the voices of all other members of the PBL group and make the extensive time and effort necessary for PBL to be "worth it." Nonetheless, this session was challenging and provides an excellent illustration of pitfalls tutors may encounter.

<u>Summary Analysis</u>

This two-minute segment illustrates patterns in conversational styles that reflect the findings of another study (Siegel & Lee, 2001) of the roles played by the members of this PBL group. By analyzing the number of turns, coding the types of utterances, and noting interactions and body language, researchers characterized the participants as:

Dean	Science authority
Cindy	Synthesizer
Paula	Questioner
Lou	Collaborator and questioner
Bo	Peripheral member

Dean acted as and was reacted to as a leader and resource in the group. In another clip from this PBL group, Dean provided the most science answers or declarative statements and asked the least number of questions (Siegel & Lee, 2001). In addition to challenging the tutor, Dean's play on terminology, combined with his sarcasm, intonation and gestures, suggest resistance to the course content and the instructional format. The resistance was also evident in interviews with Dean in which he described his frustration with PBL due to his experiences with his first PBL group led by a different tutor, and voiced suspicions of learning sciences concepts with regard to their usefulness for teaching. This resistance is important for the tutor to address because a dominant member voices it.

The talk in Segment II.2, which follows Cindy's recall, is animated and lively. Members of the group are eager to develop Cindy's idea and begin to suggest specific ways to improve the instruction in accordance with it. Given what appears to be strong group motivation at this point, it is instructive to ask how the social interactions that follow undermined the group's work and what kinds of socio-technical solutions might be possible.

Segment II.2 exposes several patterns of group interaction that could be minimized by an experienced tutor. First, overlapping talk and animated voices illustrate how motivated excitement within a group can create confusion and lack of communication: Dean has an idea but will not get a chance to share it. Bo puts forth an idea that is well received, but is cut off before having a chance to elaborate and own it. The tutor herself sees an opportunity to connect the conversational topic to an important course concept, but her words also are lost in the confusion. An important issue, then, is how to recognize and take advantage of conversational confusion, produced by motivated excitement, and manage it toward productive work. For example, one strategy for disentangling conversational threads and insuring that less dominant students get turns is to temporarily establish a speaking order ("OK, let's hear what Bo has to say and get group reactions, then let's hear Dean's idea.). Or, each student might be given a number of tokens representing the number of turns at talk allowed. Students give up a token with each turn and only when all students' tokens are depleted are they redistributed.

Second, the segment highlights a contrast between collaborative versus authoritarian talk in group work: As Cindy shares her pleasure with having learned something about static electricity, Dean jumps in to let her know she is wrong. So another important question is how to encourage collaborative sharing and reduce inappropriate authoritative talk that may reduce motivation and status for some students. Such strategies become a part of an experienced tutor's repertoire, but a system can be designed to achieve these strategies even with inexperienced tutors.

Similarly, segment II.3 illustrates additional patterns of problematic interaction that an experienced or a good system design might alleviate. One is the situation in which a dominant student is claiming or delegating ownership of a good idea that another student has contributed. Appropriate tutorial responses could include such moves as agreeing with the dominant student while giving credit to another ("Right, and we have Bo to thank for bringing that up."). A tutor can also watch for situations in which a dominant and resistant student's expressed beliefs can be used as a basis for building conceptual links and bolstering the validity of course content ("Dean has made a good point. Does anyone other than Dean have an idea about exactly how to connect this idea of atomic models to the lightning thing?)

The goal of the course is to help future teachers acquire learning science concepts and vocabulary as analytical lenses for discussing and thinking about teaching and learning. In segment III, the tutor appropriately notes an opportunity for mentoring students into the learning sciences vocabulary by asking them to focus on and name a course-relevant concept their discursive talk is reflecting. However, analysts agreed that the tutor made a mistake in framing the question, "What would I call that." Analysts noticed as problematic consistent use of the pronouns "I" "we" and "you" to reinforce and exacerbate the in-group/out-group nature of the tutor-student relationship. To maintain camaraderie and avoid emphasizing group membership, the tutor might have asked instead, "What could we call that?" or "What would the cognitive community call that?"

Segment IV illustrates a growing tension between the tutor and Dean. The issue at hand is a valid one, whether the label authentic instruction is appropriate for a given application. However, instead of taking advantage of an opportunity to explore cognitive conflict and probe a student's understanding in depth, the tutor engages in the conflict, cutting off discussion and instructing Dean to conduct further research. The assignment is directed to one student in particular and was viewed by another student (line 47) as punitive.

In the process of an escalating social conflict between Dean and the tutor, other students have been left out and ignored. Using conciliatory talk, Cindy tries to reconcile the conflict in line 54. The tutor's response following 54 might have been, "What do you mean, Cindy?" Such a question would have brought another student into the discussion and taken advantage of cognitive conflict and its resolution as a learning opportunity. However, the tutor's actual response to Dean, although instructive, demanded concession.

In evaluating this PBL segment in terms of the KBC model, it is clear that the instructional interaction is less than ideal in several respects. The interaction appears to limit possibilities for developing authentic instruction as a community concept. Although the tutor does provide some scaffolding and mentoring in helping this construct develop, the process of negotiating the meaning of this concept among students was cut off at critical moments. An escalating social conflict over classroom control, which occurred between a dominant male science student and the female tutor, a social scientist, appeared to curtail students' efforts to legitimately argue through and resolve a legitimate cognitive conflict about the nature of authentic learning and instruction. Dominance and overlapping talk in conversation sometimes diverted group attention away from important ideas offered by less-dominant students and drastically limited information sharing among students. In fact, one student did not participate at all in this segment, and analyses of other segments of the longer tape verified that this student participated very little throughout the entire unit (Siegel & Lee, 2001).

The discussion above illuminates an interesting conflict between the design goals of building a spontaneously interacting and self-sustaining community versus facilitating the construction of ideas. Other socio-technical designers have encountered this conflict in online asynchronous discussions (e.g., Cuthbert, Clark, and Linn, 2000). One project's solution was to increase the support for constructing ideas through several types of reflection prompts; however, they left the problem of how to sustain interaction as an open question (Cuthbert et al., 2000).

Designing and Institutional Context

Not all interactions within the course are problematic. Student ratings from this and subsequent semesters indicate that students believe this and similar activities are valuable and relevant to their teaching careers. However, the kinds of conflicts and resistances illustrated above are far from rare in teacher professional development (e.g., Simon, 1992) and in this case, as analysts noted, probably had multiple origins, many grounded in the following institutional contexts.

TA's with minimal training often serve as tutors as part of their own doctoral training. As noted by Steinkuehler, Derry, Hmelo & DelMarcelle (2002), the high turnover rate endemic to such positions means that each semester, the course manager may have to start over with a new group of tutors. As is typical, the beginning TA in this segment had little teaching experience. Although relative to the student teachers she was advanced in terms of her knowledge of the learning sciences content, she was not versed in the science that was the topic of the case discussion. This situation likely exacerbated a perceived status difference between the pre-service students, all senior-level science majors, and the tutor, a graduate student but still a social scientist. Second, while the students belonged to a cohesive cohort that had worked together for two years, the tutor was a newcomer, an outsider "imposed" upon them along with a third-semester required course. Further, a course in educational foundations that deals with learning theory may not seem useful to students who are concerned with developing practical methods and anxious to get on with the business of actually teaching. Also, these students had previously taken education courses with teacher education professors whose philosophies and approaches may be in conflict with premises of the learning sciences foundations course. This is the pervasive problem of ideational fragmentation in teacher education as discussed by Ball (2000) and others.

We are attempting to engineer a socio-technical solution to many of these problems, although these solutions may appear quite different from those we originally envisioned and proposed. Originally our plan was to bring pre-service teachers together online with instructional staff, disciplinary mentors (subject-matter specialists), and cooperating teachers, to work on instructional projects that would be implemented by student teachers in classrooms. Our vision was that such teams would work together online in a relatively unstructured synchronous discussion environment.

Our reality three years later is that we have created a more structured socio-technical design, including a communications technology, instructional materials and social activities, to guide student teachers' thinking and help them acquire course content as they work collaboratively to design instruction they will perceive as having immediate and future usefulness. A central part of that design is the STEP pbl[1] System, currently in use by the educational foundations courses at Rutgers University and UW-Madison. This system provides scaffolding to guide individual students and groups through pbl problems, and both training and scaffolding to support the tutoring process and help TA's function as online facilitators. An earlier pilot version of STEP pbl was described in Steinkuehler et al. (2002). The following description of the substantially revised system that is currently in use at UW-Madison and Rutgers University is taken from Derry & The STEP Team (in press), a source that also provides a theory-based discussion of the design of the full STEP environment, including the case library and online hypertext book, which together comprise the STEP Knowledge Web (KWeb) that is integrated with STEP pbl.

The STEP pbl System

The STEP pbl system scaffolds online instruction in which students deepen their understanding of learning sciences as they work collaboratively, or collaboratively share and discuss individual work, on various types of problems. Course managers can create new problems and customize the system in various ways to meet various instructional needs. The system is described below using an instructional design challenge that was created for mathematics majors in the fall, 2002, learning sciences course at UW-Madison. This example is a prototype but it illustrates only one of many possible forms that STEP pbl instruction can take.

Several years ago, PBL was introduced into the STEP course as a face-to-face small-group method that was practiced once a week in the classroom. It was introduced simultaneously with the STEP KWeb (which did not at that time have a site supporting online problem-based learning). PBL presented cases of instruction to be improved, and the instructional design projects lasted several weeks. Between classes, students conducted research using the STEP web site and other resources. The group that we described previously in this chapter consisted of five science

[1] We use "PBL" to refer to the Problem–Based Learning technique originally designed by Barrows (1985); we use "pbl" (all lowercase letters) to refer to the modified version of problem–based learning used by STEP. We maintain this distinction throughout our work in order to acknowledge the fact that we have modified the procedure and employ online asynchronous discussions while Barrows specifies that such discussions should always occur synchronously.

education majors and their tutor, one of the earliest PBL groups in the course. Our studies of this group and our observations of the STEP course as a whole led us to conclude that PBL is a difficult instructional method, unlike any that most people have experienced. The facilitation of PBL is important to its success and the unseasoned TA's who served as facilitators for PBL groups struggle with it. Student teachers are often initially resistant to the unfamiliar method, and there are larger institutional and program contexts that make it likely that conflicts will arise. PBL is also resource intensive since one trained, preferably experienced, facilitator is required for every 7-10 students. In large courses, tutors must monitor multiple groups. This is a substantial burden for TA's, but we felt this was a problem that might be addressed through technology.

Hence we created and added to our website the STEP pbl system for online support of problem based learning. The STEP pbl system is a collaborative environment that is integrated with other eSTEPWeb.org resources. The STEP pbl system supports either online small-group instruction or a hybrid model in which students meet face-to-face in small groups during class and then extend their work outside of class through online interaction. In both online and hybrid models, students are guided by a human facilitator, typically a teaching assistant, and are required to complete and submit individual and group artifacts, typically products related to and documenting various stages of instructional design, through the online system. The online system collects and displays data on student performance and affords detailed monitoring of work by individuals and small groups, permitting detailed (and powerful) formative assessment of individuals and groups throughout the course.

Although they can be set up in different ways by the course manager, most STEP pbl activities so far have included a phase of individual study and preparation, followed by a phase of facilitated small-group design work, followed by a final phase in which the individual analyzes, extends, and reflects upon the group's work and how much the individual gained from it. The online environment guides students through a series of steps. The number of steps and required activities for each step may vary from problem to problem, as desired by the course manager/designer. Here we describe one of the activities created for the fall, 2002, course at UW Madison, which took students through a four-week, nine-step design challenge. This example was the second online activity completed by the mathematics majors. Pbl problems customized to specific disciplines were also assigned to students in secondary science, English, social studies, and foreign language.

When students entered the STEP pbl system to start their design challenge, they saw a "sidewalk" with nine steps, each step associated with a particular due date for completion (Figure 2). Each student began the task by mouse clicking on step 1, which opened a page of instructions and a design problem appropriate to that student's academic teacher certification area. The design problem for mathematics majors, Bridging Instruction in Mathematics, is shown in Figure 3. Previously, each student had been assigned to a small discipline-based work group that was maintained in this problem activity and throughout the course.

Like design problems for other disciplines, the mathematics problem referenced and linked to a particular video case in the STEP video library, a classroom story that students were asked to analyze in preparation for their design work. Students were asked to draw lessons and ideas from the case under study and then apply those lessons and ideas by working with their group to design or redesign a similar type of instruction. All design problems for all disciplines required students to warrant their instructional designs through learning science research. This research was facilitated by availability of the STEP KWeb, the online hypertext book (Figure 6) of learning sciences concepts and library of classroom video cases (Figure 7), which is integrated with the STEP pbl system.

Pbl activities in the fall, 2002, UW-Madison course required students to apply a process of "backward design" leading to the creation of a "group product," a plan for an instructional unit. The unit to be developed in the mathematics teachers' groups (see their problem) was to employ an approach based on bridging instruction (e.g., Nathan & Koedinger, 2000) in which teachers employ students' prior knowledge to help them create a mathematical situational model prior to developing a solution equation (the approach used in the video case the students were required to study). Students learned about backward design through readings in the KWeb and an assigned text. Adhering to the steps in their pbl "sidewalk," students first completed their reading assignments and studied their case, entering their thoughts and reflections about the case into an online notebook (see Figure 4). After completing initial assignments by the date due, students were at Step 3, where they viewed each others' preliminary work and then joined their group of 4-5 other students on line and began working together to plan an instructional unit. Groups were allowed to choose whether to work online at all times or to supplement online work with face-to-face meetings during class. Most groups continued to meet face to face, at least occasionally.

During the instructional design phase in steps 4-6, the pre-service teachers were scaffolded, by the system and by a tutor, though a group process in which they first decided upon what "enduring understandings" their unit would teach. Next, they developed ideas for how they would assess their students, to determine whether goals for understanding were being acquired. Finally, they worked together to design goal-related instructional activities. Each step in the process involved submission and discussion of the various teacher-learners' ideas for goals, assessments, and activities. Ideas were refined online through discussion and voting, with ideas receiving strongest group support becoming part of the final group product. Group activity was supported online by a group whiteboard (Figure 5 shows the whiteboard for a mathematics group viewed through the tutor's interface) and a supplementary discussion board. As shown in Figure 5, the whiteboard contained sections (marked by "tabs") for each stage of the groups' work. For example, during the design-of-assessments stage, the group members worked within the assessment tab of the group whiteboard. During each major phase of the group activity, such as the assessment or activities design phases, students entered their "proposals" for what the group's design should include, plus a justification for their proposals, onto the group whiteboard. Students also used the group whiteboard to view and comment on others' proposals and justifications, read comments about their own proposals made by group members or the tutor, and modify their own proposals in response to feedback. Students controlled what the system put into their final product with a voting mechanism through which proposals receiving group support were automatically included in a group product that could be viewed by clicking on step 6. Upon finishing the group product -- a justified plan for an instructional unit specifying goals, assessments and activities -- individual students completed steps 7-9 individually. In step 7 individual students wrote their own critique and analysis of the group product. In step 8 students reflected on their learning, and in step 9 provided anonymous feedback on the activity and site. The tutor monitored and provided technical and conceptual assistance during every step in the activity.

Thus, the group whiteboard, as set up for this activity, required students to design an instructional unit, thinking about assessments and activities in a certain order and in terms of how they would lead to the enduring understandings that the group had established as their instructional goals. The STEP pbl is a general tool that allows course managers to change these requirements by altering the number of tabs, tab headings, and instructions to learners within each tab.

A TA facilitated all steps online. Each TA in the fall course managed four small groups of about five or six students each. An online tutoring tool that permitted monitoring of each group and individual facilitated the TA's task. The tutoring tool provided instructions and assistance for tutors, including a history of advice from previous tutors. As previously noted, the screen shot in Figure 5 is taken from the tutor's tool and illustrates how a tutor accesses and participates in group work through the tool's interface.

Students Ratings of STEP pbl Activities and Site Tools

Students in the fall UW-Madison course participated in two instructional design pbl activities, similar to the one described above. Based on a class size of 60 and a response rate of about 97%, ratings of components of the two pbl activities and the system tools used during the pbl activities indicated that they were valued and generally well received. Several patterns in these responses were observed. First, from pbl-1 to pbl-2, there was a substantial increase in student satisfaction. This is likely due to a number of factors, including student and TA experience with the method and system, as well as the use of discipline-specific cases and problems in pbl-2 (rather than the generic instructional design scenario grounded in a case on design-based instruction in a science class, which was employed in pbl-1). Also, it is notable that the most rewarding activities for students were those involving collaboration rather than individual work. Also, a highly rated tool was the hypertext and case-based information resource, the STEP KWeb. A sample of student ratings of the instruction and system, aggregated by disciplinary group, is provided in Table 1. Although all ratings were generally positive, these ratings indicate that not all disciplinary groups were equally well served, an issue to be investigated further.

That students perceived the activity as useful is indicated by the following "anonymous" assessments that were made in response the question, "How will you use what you have learned in your future teaching practice?" Two characteristic responses are supplied for each discipline.

English:

I will make it a goal to utilize this method in designing curriculum for my classes.

I will definitely use aspects of backward design in my planning. I find myself now in designing courses for next semester thinking about enduring understandings and assessments before I jump into planning activities throughout the course . . . I will also take away conscious choices a *teacher has to make when teaching controversial topics. Censorship and getting into trouble over a book seemed in far away school districts until this activity.*

<u>Social studies</u>:

I would use the unit itself. It was a good final product. I would also use this method of creating lesson plans.

I found this process an exciting way to design lessons. It held me, as a teacher, to a high standard to justify lesson plans and choosing the most important understandings in a topic.

<u>Foreign language</u>:

I would definitely like to use this unit when I teach and the different assessments and activities that my group came up with. It is really nice to see others' viewpoints on the same unit because you are able to see different perspectives that can give you some new and different ideas.

The plan that we made up as a group will be something that will be extremely useful for me as a teacher. I also learned the value of input from others and how it can help you design a unit. I also learned how time consuming planning a unit can be.

<u>Science</u>

I will try to use this process of developing lessons. I will also consult other teachers when developing a lesson to try and incorporate multiple ideas.

I will be sure to cover these areas thoroughly with other teachers involved in designing a lesson as well as using my colleagues for feedback. There were several ideas I had that they said, "no, that won't work because . . . " and they were reasons I had never thought of.

<u>Mathematics:</u>

Well, this lesson we have designed as a group is definitely something I could see myself using down the road when I have my own classroom. I feel it is a well thought out lesson that can be easily modified to meet the needs of whatever type of class "make-up" that I may have.

I will attempt to use this method when creating lesson plans for next semester. I think it is a valid model that helps the teacher keeps objectives clear and plan meaningful activities which cater to the objectives.

Concluding Comments

Many researchers (Ball, 2000, Wideen et al. 1998) have argued that divisions among departments, schools and courses are creating a structural fragmentation (Wideen et al., 1998, p. 161) within teacher education programs. Ball (2000) suggested that the fragmentation appears in the prevailing curriculum of teacher education by imparting knowledge in different domains, such as educational psychology, sociology of education, foundations, methods of teaching, and the subject matter disciplinary knowledge. She suggested that this kind of fragmentation creates a difficult challenge for beginning teachers, who must integrate disparate or conflicting pieces of knowledge into the contexts of classroom practice. There are also conflicting messages (Borko & Putnam, 1996) that confuse novice teachers because their practicum and student teaching experiences may be very different from approaches advocated in the teacher education programs.

Also, preservice teachers' learning experiences are affected by their beliefs that they bring with them from personal life experience, schooling, instructional experience, and formal knowledge experience (Richardson, 1996). Because these beliefs are a collection of influences in the life of teachers, beliefs act as filters (Borko & Putnam, 1996, Wideen et al. 1998, p. 145, Richarson, 1996). One common belief held by entering preservice teachers is that experience is the best teacher (Richardson, 1996, p. 108). The receptivity of the student teachers to the knowledge that teacher educators wish to impart in the teacher education program depends very much on how these prior beliefs are addressed. Many studies on teaching interventions, such as the Second-Grade Mathematics project by Cobb et al. and the Cognitively Guided Instruction project by Carpenter et al., have shown that the way teachers teach and learn depends on whether their beliefs are confronted in ways that allows for change to take place (Borko & Putnam, 1996). Beliefs should be surfaced and acknowledged during teacher education programs if programs are to make a difference in the deep structure of knowledge and beliefs held by the students (Richardson, 1996).

The challenge for teacher education thus goes beyond imparting a knowledge base that is, at best, uncertain, to fostering a discourse that incorporates the preconceptions and varied interests and messages that affect how student teachers view and learn from their teacher education programs. This is a difficult instructional design problem, particularly in the context of large university programs that may provide a supporting environment in some ways, but also must deal with problems of departmental fragmentation, limited resources, placing responsibility on relatively inexperienced teaching assistants, substantial turnover among instructional staff, overloaded senior faculty, and social conflicts created by personalities, status differences and institutional contexts.

We have described our recent attempts to address some of these problems through design of a socio-technical environment for shaping group interactions so that they are in greater accord with a KBC model of learning, which encourages diverse viewpoints and mentored work activities that involve interaction among those viewpoints. We began with a more ambitious vision for a larger, more cohesive online community, but this vision could not be immediately realized, largely because the change required to achieve it would be too great and would involve overcoming many socially and historically rooted forces of resistance. We scaled back to a more modest goal, to create a model for that part of the curriculum in which learning sciences are infused into the teacher education program. Our approach engages small groups of students in mentored problem-based learning activities that involve analysis and design of learning environments.

Prior to the online version of STEP pbl, PBL learning activities took place in classrooms. We studied discourse in these classrooms in conjunction with considering the program's broader social contexts and their possible reflection in classroom discourse. We observed that many pedagogical demands are placed on relatively untrained and inexperienced TA's. Various contextual issues, such as conflicting voices and goals and discipline-based status differences within the program, exacerbate the difficulty of a TA's position. It is not surprising that conflict occurs and that a TA might have trouble managing it. Moreover, large-course implementation requires that TA's manage several pbl groups at once. We concluded that an online approach to the course might alleviate many of these problems. Our design provides a structured and supportive environment for facilitated, online problem based learning. Because students investigate and discuss learning sciences in the context of design problems, they have the opportunity to socially construct knowledge about learning sciences and integrate it with other points of view as they work on authentic instructional tasks that are perceived as meaningful. The instructional design problem for us is how to scaffold and support social knowledge construction through system design. The evolving solution is the STEP pbl System reported here.

Did our original vision fail? Definitely not. Consistent with other accounts in this volume (Barab, MaKinster, & Scheckler, this volume; Schlager & Fusco, this volume), our greatest error was the naïve idea that we could pull one already-complex community into the shape of a newly envisioned complex community, in one fell swoop. Designing a knowledge-building community requires the support and active participation from many people, and the altering of many ingrained habits, communication channels and beliefs. Bringing these changes about is an evolutionary process. It takes time, and substantial grant money helps. Socio-technical communities evolve simultaneously as social systems and interwoven technologies. STEP is at an intermediate stage of its evolution. Cooperating teachers are not yet real members of the STEP community, but there are important roles for teachers in the structure we have designed and we will soon be ready to actively court their participation. The STEP pbl system currently serves only one type of foundations course, but we are organizing projects involving cross-course use of STEP resources in vertical and horizontal curriculum integration. For example, we are now developing cases for joint, coordinated use in methods, psychology, and diversity courses. So the original vision is not lost; in many ways we are slowly moving toward it. Through our work we will continually develop and integrate the STEP pbl system so that it becomes part of and facilitates the evolution of our existing community.

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Figure Captions

Figure 1. A Knowledge-Building Community Model from Derry, Gance, Gance & Schlager, 2000

Figure 2. STEP pbl System Interface

Figure 3. STEP pbl Problem for Mathematics

Figure 4. STEP pbl Student Online Notebook

Figure 5. STEP pbl Tutor Interface Showing Group Whiteboard with Student Work

Figure 6. Page from STEP Knowledge Web Hyptertext on Learning Science Theories

Figure 7. Page from STEP Case Library

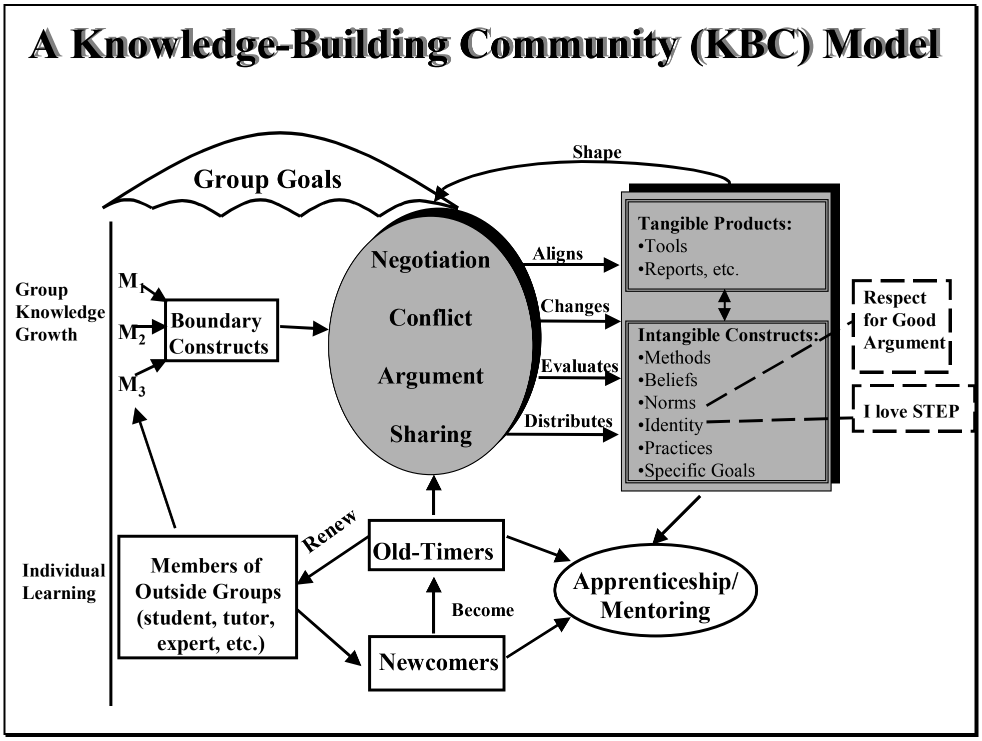
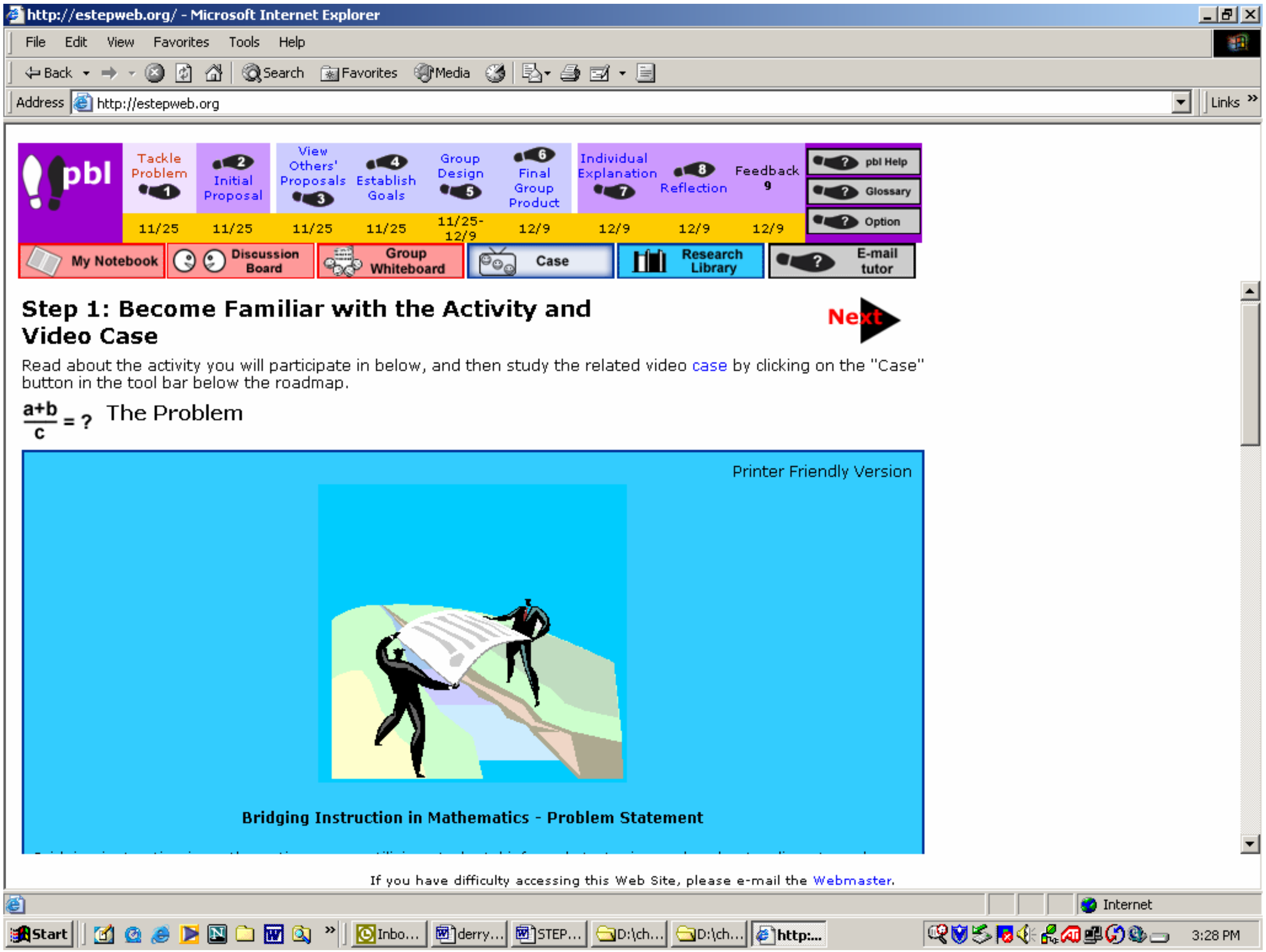


Figure 1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pbl
Tackle Problem 1
Initial Proposal 2
View Others' Proposals 3
Establish Goals 4
Group Design 5
Final Group Product 6
Individual Explanation 7
Reflection 8
Feedback 9
11/25 11/25 11/25 11/25 11/25-12/9 12/9 12/9 12/9 12/9
pbl Help
Glossary
Option
My Notebook
Discussion Board
Group Whiteboard
Case
Research Library
E-mail tutor
Step 1: Become Familiar with the Activity and Video Case
Next
Read about the activity you will participate in below, and then study the related video case by clicking on the "Case" button in the tool bar below the roadmap.
The Problem
Printer Friendly Version
Bridging Instruction in Mathematics - Problem Statement
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Figure 2

Bridging Instruction in Mathematics - Problem Statement

Bridging instruction in mathematics means utilizing students' informal strategies and understandings to make sense of more formal mathematical strategies and representations. The classroom depicted in this video case (Case 6: Boulder Math) is an example of an effort to implement this concept of bridging to help 6th grade students make the transition from arithmetic to algebraic types of reasoning that will be critical to their success in pre-algebra and algebra classes in middle and high school. The case includes video taken from five class sessions, although the organization of the cases is largely thematic as opposed to sequential. The teacher in this case worked closely with Dr. Mitchell Nathan in the development, implementation and recording of these lessons. The lessons revolve around the class's efforts over several class periods to solve word problems, many of which were authored by students in this class. An example problem is listed below:

<table>
<tr><td colspan="2">Basketball Problem: A Dad and his four daughters went to a sporting goods store to look for a basketball. The daughters wanted to purchase a basketball for $42. The Dad said he would pay $18, but that the daughters would need to pay for the remaining cost. If the daughters pay for the rest, how much does each daughter need to contribute for their share?</td></tr>
<tr><td>Situation Equation</td><td>Solution Equation</td></tr>
<tr><td>(4 X D) + $18 == $42

D = Amount of money each daughter pays</td><td>($42 - $18)/4 = $6</td></tr>
</table>

Students at this level of development are often able to arrive at "the answer" to this type of question through strategies such as unwinding (See Nathan/Koedinger articles in the cases's Inquiry Materials for a more thorough explanation of student strategies). In the basketball problem students will often start with the total cost of the basketball, $42 and "unwind" or work backwards until they reach a solution. They might say, "If the basketball costs $42 and Dad gives me $18, then we can subtract 18 from 42 and we only need to pay $24. Since there are four of us, we will divide 24 by 4 and each pay $6." These operations are then depicted in the solution equation column. What the teacher is trying to do with these problems is help students represent the situation using an algebraic model that doesn't yet answer the question. So she tries to help them create a mathematical description of the situation, shown in the situation column, and uses various methods to accomplish this, including having them develop and act out skits of the situation for the class. On several occasions she even films (only briefly depicted in this case) these skits, so that students are able to reflect on what occurred as it relates to the mathematical representations of the situation. Once they have developed these two representations of the problem, situation and solution equations, she asks them to examine the structure of these two mathematical sentences to see how they are related. In this way they can "bridge" the relationship between their representation and strategies from the solution equation, and the target representation depicted by the situation equation.

From a learning sciences perspective this case has many interesting facets as well. Bridging curriculum begins with what the students already know how to do and attempts to build on their prior knowledge and representations. This case also demonstrates various methods and tools for involving students in their learning and building on their contributions, including using problems they authored as part of the instruction. The teacher uses these problems in interesting ways, revisiting previously solved problems on several occasions to draw out new relationships. Another point of interest is the fact that this teacher was working hand-in-hand with researchers who are experts in both the subject domains of algebra learning/teaching and the learning sciences, who were trying to apply what they had discovered about student and teacher strategies into an actual classroom.

This case revolves around the class' interaction with various word problems. Of particular interest are students' efforts to move from informal strategies depicted in the result-unknown solution equations to more symbolic beginning-unknown representations of the problem in the situation equations, and their understanding of the relationships between the two. In order to get the most from this case, it is highly recommended that you review the math problem index in the inquiry materials and become familiar with the problem statements and situation and solution equations so that you can better understand the students' activities.

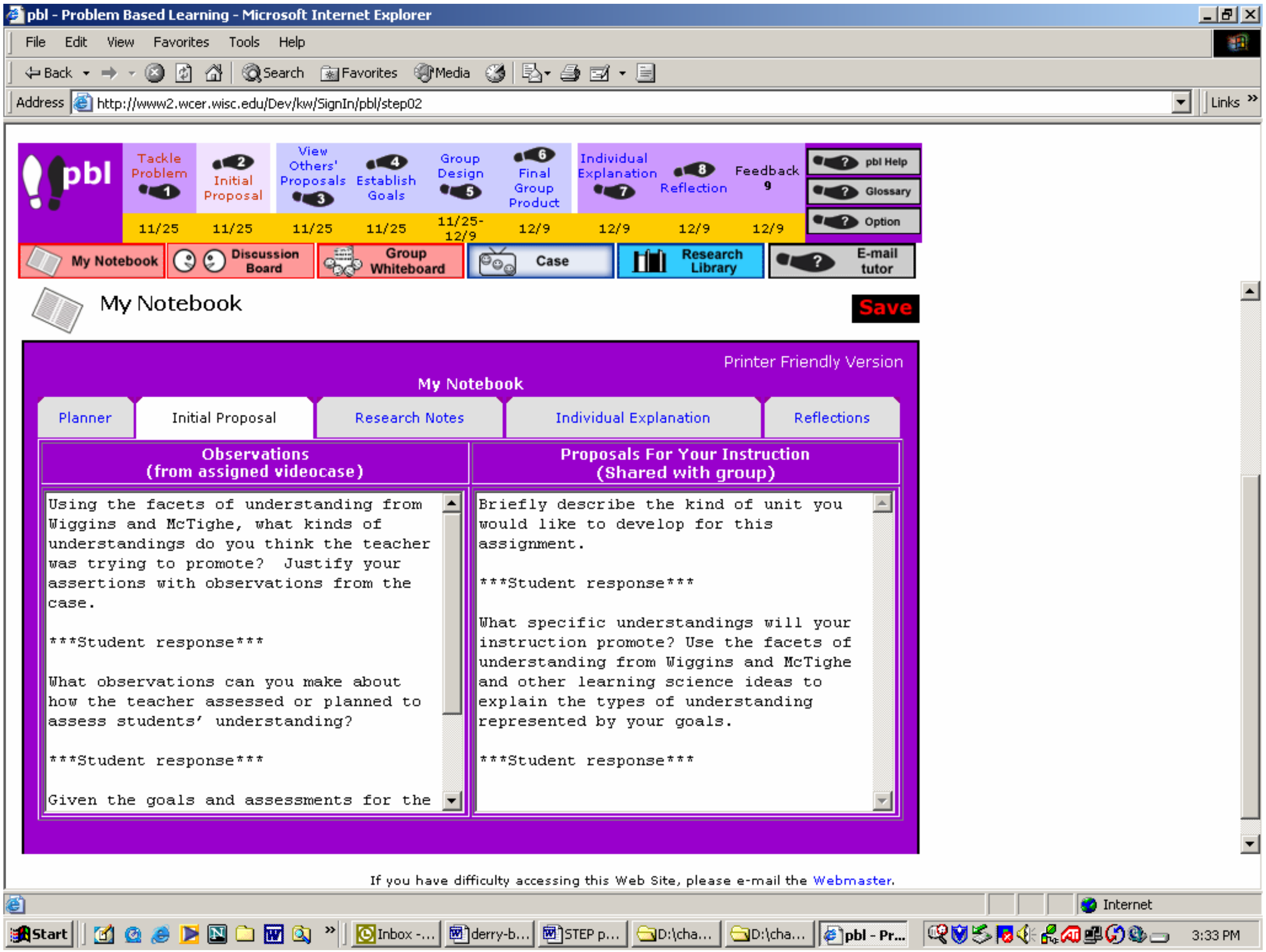
Your Task:

After studying the video case, your group's task is to design its own bridging instruction unit, where the objective is to identify and incorporate students' informal strategies into the target strategies and representations of your unit. You may choose to redesign the unit depicted in this case, or to use it as a model to design a unit on a topic of interest to you. As you watch the video try to answer the following questions:·

- What do you think the teacher is trying to accomplish?
- Why is she doing what she is doing?
- How useful are the activities?
- How would you build on what seems to be working?
- What changes would you make and why?
- What instructional activities would you include?
- What types of assessments would you use to evaluate your own teaching and your students' progress?

To answer these questions and complete your design assignment you will need to become familiar with the problems described in the inquiry materials, read the articles by Nathan & Koedinger on teachers' and students' understandings of the development of algebraic reasoning, and investigate the learning science concepts listed within each minicase. Your group will then need to determine whether they want to redesign the unit depicted in this case, or apply the principles and methods from this case to a related unit of interest. Once this is decided the group should evaluate the case together and identify their target enduring understandings (see Wiggins and McTighe textbook) they want from their unit. Following these decisions, your group will generate and develop proposals for assessments and instructional activities that will support the enduring understandings. These are the only real parameters of the activity. It is up to the group to make any other design decisions that aren't specified here. ***Good Luck!!***

Figure 3


pbl - Problem Based Learning - Microsoft Internet Explorer
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Tackle Problem 1
Initial Proposal 2
View Others' Proposals 3
Establish Goals 4
Group Design 5
Final Group Product 6
Individual Explanation 7
Reflection 8
Feedback 9
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pbl Help
Glossary
Option
My Notebook
Discussion Board
Group Whiteboard
Case
Research Library
E-mail tutor
My Notebook
Save
Printer Friendly Version
My Notebook
Planner
Initial Proposal
Research Notes
Individual Explanation
Reflections
Observations (from assigned videocase)
Proposals For Your Instruction (Shared with group)
Using the facets of understanding from Wiggins and McTighe, what kinds of understandings do you think the teacher was trying to promote? Justify your assertions with observations from the case.
Student response
What observations can you make about how the teacher assessed or planned to assess students' understanding?
Student response
Given the goals and assessments for the
Briefly describe the kind of unit you would like to develop for this assignment.
Student response
What specific understandings will your instruction promote? Use the facets of understanding from Wiggins and McTighe and other learning science ideas to explain the types of understanding represented by your goals.
Student response
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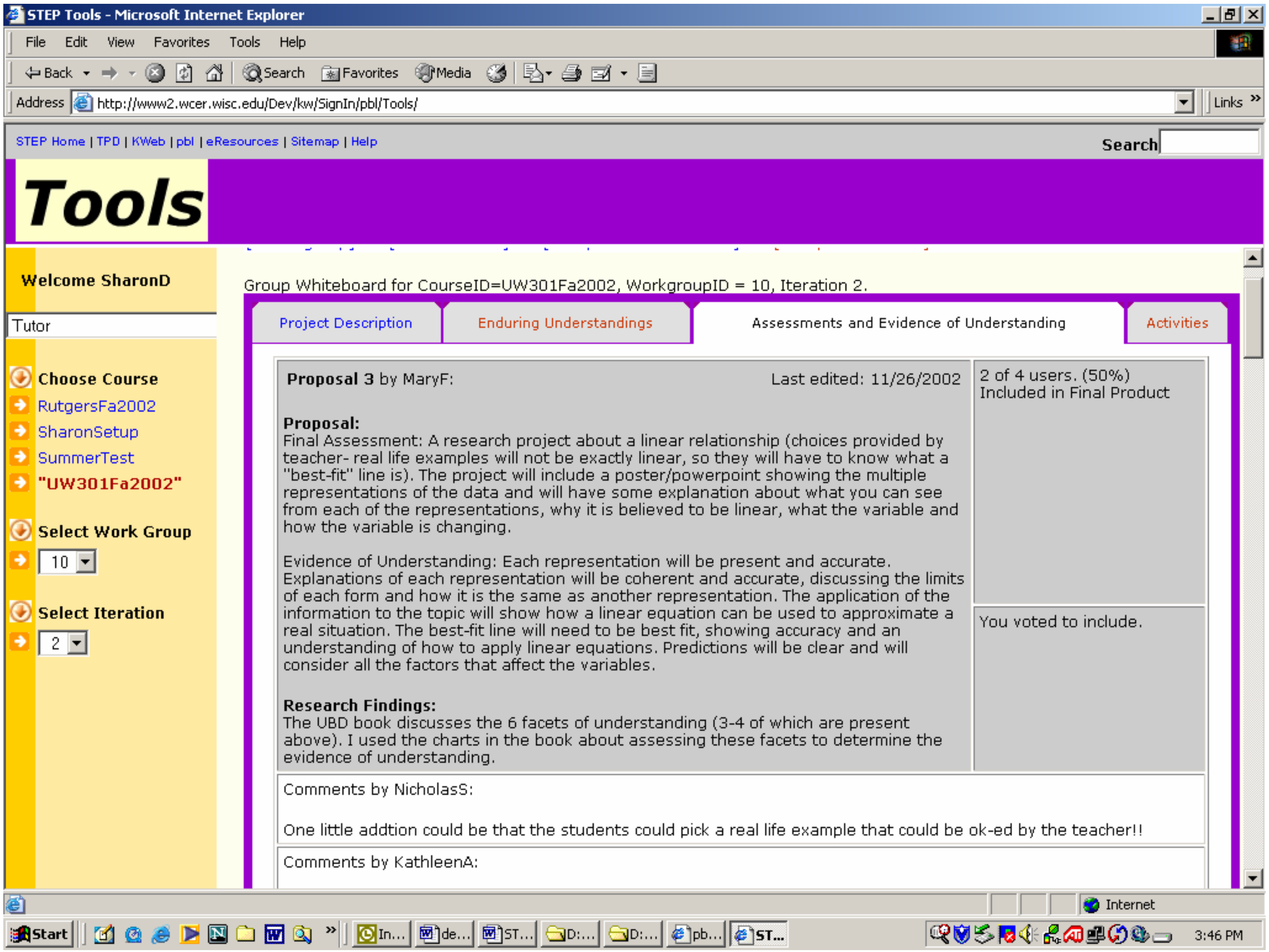
Figure 4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Project Description
Enduring Understandings
Assessments and Evidence of Understanding
Activities
Proposal 3 by MaryF:
Last edited: 11/26/2002
2 of 4 users. (50%) Included in Final Product
Proposal:
Final Assessment: A research project about a linear relationship (choices provided by teacher- real life examples will not be exactly linear, so they will have to know what a "best-fit" line is). The project will include a poster/powerpoint showing the multiple representations of the data and will have some explanation about what you can see from each of the representations, why it is believed to be linear, what the variable and how the variable is changing.
Evidence of Understanding: Each representation will be present and accurate. Explanations of each representation will be coherent and accurate, discussing the limits of each form and how it is the same as another representation. The application of the information to the topic will show how a linear equation can be used to approximate a real situation. The best-fit line will need to be best fit, showing accuracy and an understanding of how to apply linear equations. Predictions will be clear and will consider all the factors that affect the variables.
You voted to include.
Research Findings:
The UBD book discusses the 6 facets of understanding (3-4 of which are present above). I used the charts in the book about assessing these facets to determine the evidence of understanding.
Comments by NicholasS:
One little addtion could be that the students could pick a real life example that could be ok-ed by the teacher!!
Comments by KathleenA:
Internet
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3:46 PM

Figure 5


Knowledge Construction - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites Media
Address http://www2.wcer.wisc.edu/Dev/theories/TheoreticalPerspectives/CognitiveTheory/KnowledgeConstruction
Links
eSTEP: The Project
Sitemap Help Search
eSTEPWEB HOME
KW Theories
HOME ABOUT KWEB KW CASES KW THEORIES PBL GALLERY
COGNITIVE THEORY
SOCIOCULTURAL THEORY
CROSS-THEORY IDEAS
Information Processing Theory
Adaptive Expertise
Knowledge Construction
Knowledge Representation
Metacognition
Prior Knowledge Use
Problem Solving
Sociocognitive Theory
Knowledge Construction
Bookmark this page
Students build their knowledge base by adding new information into their existing knowledge structures
The term 'construction' in a general sense implies that some sort of action involving "building" occurs. It may conjure up images of how construction crews erect new structures or add to existing ones. Construction workers engage in hands on, in-the-trenches kinds of work, and they go home after a hard day of work with grime and dirt on their faces, remnants of the sweat and toils of their labor. But when they're done, they have something meaningful to show for it, and this is often what propels these men and women to continue to tackle new and more adventurous projects.
The parallels between construction workers and learners seem obvious, don't they? Relating students to construction workers as described in the above passage is indeed a metaphor, but when one looks more closely at how people actually learn, there are many parallels.
Minus the hard hat, learners are actively involved in constructing their own knowledge. Knowledge construction is a process in which students actively try to make sense of information and the world around them by seeking meaningful connections between their prior knowledge and new knowledge in ways that lead to comprehension. After all, knowledge does not just magically appear in a learner's mind, just as buildings do not construct themselves. It takes work—maybe not always the kind that involves sweating, but it almost always involves some activity on the part of the learner. Armed with this understanding, a teacher must focus on facilitating knowledge construction by first
Related Concepts
Printer-friendly version
PARENT IDEAS:
• Cognitive Theory
• Cross-Theory Ideas
Knowledge Construction
CHILD IDEAS:
• Comprehending
• Concept Learning
• Depth of Processing and Active Learning
• Elaborative Encoding
• Problem Solving
• Self Explanation
OTHER RELATED IDEAS:
• Adaptive Expertise
• Conceptual Change
• Designing to Learn
• Information Processing Theory
• Knowledge Representation
• Metacognition
• Prior Knowledge Use
• Problem Solving
• Situation Models
• Social Knowledge Construction
• Sociocognitive Theory
• Transfer
Related Video Clips
• 1-4. Rushing Material Coverage
• 1-7. Social Knowledge Construction When the Teacher Isn't Sure
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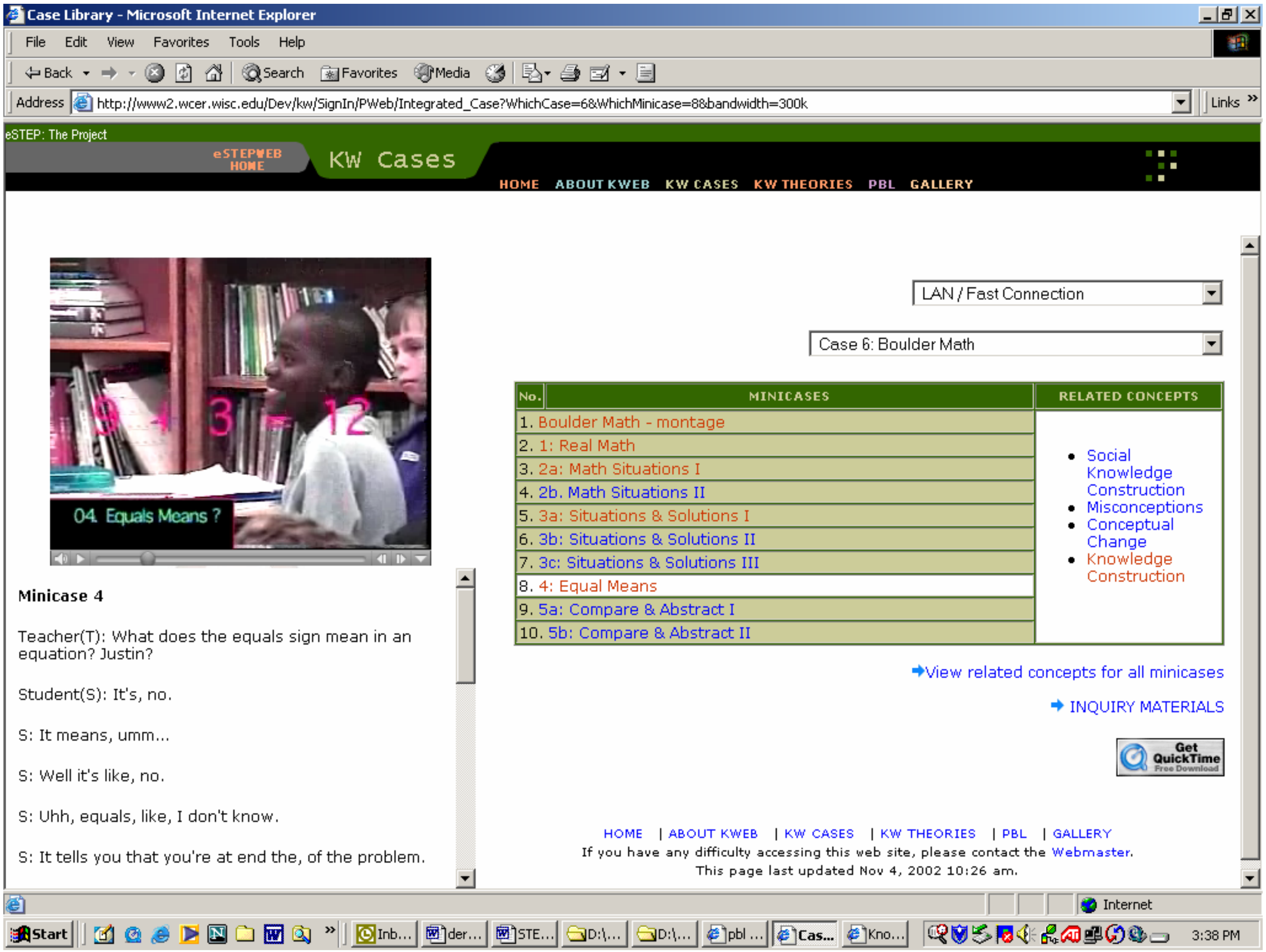
Figure 6


Case Library - Microsoft Internet Explorer
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Address http://www2.wcer.wisc.edu/Dev/kw/SignIn/PWeb/Integrated_Case?WhichCase=6&WhichMinicase=8&bandwidth=300k
eSTEP: The Project
eSTEPWEB HOME
KW Cases
HOME ABOUT KWEB KW CASES KW THEORIES PBL GALLERY
04 Equals Means ?
LAN / Fast Connection
Case 6: Boulder Math
No. MINICASES RELATED CONCEPTS
1. Boulder Math - montage
2. 1: Real Math
3. 2a: Math Situations I
4. 2b. Math Situations II
5. 3a: Situations & Solutions I
6. 3b: Situations & Solutions II
7. 3c: Situations & Solutions III
8. 4: Equal Means
9. 5a: Compare & Abstract I
10. 5b: Compare & Abstract II
Social Knowledge Construction
Misconceptions
Conceptual Change
Knowledge Construction
Minicase 4
Teacher(T): What does the equals sign mean in an equation? Justin?
Student(S): It's, no.
S: It means, umm...
S: Well it's like, no.
S: Uhh, equals, like, I don't know.
S: It tells you that you're at end the, of the problem.
View related concepts for all minicases
INQUIRY MATERIALS
Get QuickTime
HOME | ABOUT KWEB | KW CASES | KW THEORIES | PBL | GALLERY
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Figure 7

Table 1. Sample of Student Ratings of Two STEP pbl Experiences by Disciplines

	Time 1	Time 2
How much did you learn from pbl activity overall (1= Nothing – 5= A Lot)?		
English (n=8)	3.75	4.5
Language (n=5.5)	4.0	4.36
Math (n=12.5)	3.8	3.9
Science (n=12.5)	3.8	4.6
Social Studies (n=11)	3.7	4.6
How much did you learn from the group design steps (1=Nothing – 5 = A Lot)?		
English (n=11)	3.9	4.5
Language (n=5.5)	4.4	4.7
Math (n=14)	3.57	4.4
Science (n=13.5)	4.1	4.5
Social Studies (n=14)	4.1	4.1
How well did the Knowledge Web work for you (1=Very poorly – 5 = Very Well)?		
English (n=11)	4.1	4.8
Language (5.5)	4.6	4.3
Math (n=14)	4.2	4.4
Science (n=13.5)	4.4	4.6
Social Studies (n=12.5)	4.3	4.2