A Reflective Analysis of Facilitation in an Online Problem-Based Learning Activity

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Abstract: The first author collaborated with the second to analyze his facilitation of online problem-based learning (PBL). A framework for analyzing reflective collaboration in science instruction developed by Radinsky (2000) was adapted to examine threaded discourse in an online teacher education course. In the spirit of Schön (1983), we proffer this method as a tool for analyzing and improving one's online facilitation of PBL and for developing scientific hypotheses about connections between facilitation and learning.

Introduction

We present a method for evaluating discourse in online problem-based learning (PBL) groups while simultaneously helping new online facilitators (usually graduate students) reflect on how their facilitation affects that discourse. We illustrate the method using data collected during a problem-based learning (PBL) activity implemented entirely online as part of a learning-sciences course for pre-service teachers. PBL is a form of instruction in which learners collaboratively engage in ecologically valid problems with the goal of promoting transfer of knowledge to professional practice (Barrows, 1988; Koschmann et al., 1994;). PBL is a student-centered form of instruction that replaces the teacher with multiple small-group facilitators (Dolmans & Schmidt, 2000; Meyers Kelson & Distlehorst, 2000). The facilitator operates as a guide who pushes students to think deeply and work effectively (Dolmans & Schmidt, 2000; Hmelo & Lin, 2000; Koschmann, Glenn, & Conlee, 2000). During the online PBL activity in the present study, one of the authors ("MD") served as the facilitator. Following the activity, we employed a method for analyzing patterns in collaborative discourse, based on a framework by Radinsky et al. (2000), to create explicit graphical representations of group interaction. These representations became objects for supporting analysis of facilitation strategies, which took place in post-course reflection sessions. In the spirit of Schön (1983), we claim that this method for supporting structured reflection is not just a tool for analyzing and improving one's teaching, but also a methodology for developing scientific hypotheses about connections between small-group facilitation and learning.

In online PBL, the role of the facilitator is complex and multifaceted. He or she is responsible for monitoring student and group process as well as the progress and understanding of individuals. Unlike a typical classroom setting in which the teacher does 95 percent of the questioning and tends to focus on short-answer questions (Dillion, 1990; Graesser & Person, 1994), PBL aims to be much more student-centered. Fostering reflective, constructive discourse wherein much of the questioning is done by the students is a major goal of PBL. To accomplish this, the facilitator tends to ask a variety of complex questions that focus students not only on the domain and problem but also on group processes while at the same time scaffolding students to assume responsibility for self-directed collaborative learning (Hmelo, 1998; Hmelo & Lin, 2000; Persons & Graesser, 1999). Looking at face-to-face PBL instruction, Hmelo-Silver (2003) studied Howard Barrows, the acknowledged founder of PBL and a well-known facilitator, to gain a better understanding expert facilitation. The nature of expert PBL facilitation was not easily captured: it is a complex and often subtle form of practice. Not surprisingly, it can be an extremely challenging pedagogy for new facilitators to master in face-to-face situations (Derry et al., 2004). Although asynchronous tools within online PBL environments my slow the speed of interaction, decreasing facilitators' cognitive load and allowing more time for reflection during facilitation, the online environment nevertheless adds an additional aspect of unfamiliarity and, as this study will illustrate, challenges for those learning to facilitate PBL on line.

The Context

The present study utilized data collected from an online course for preservice teachers focusing on the learning sciences, particularly cognitive and sociocultural theories of learning and instruction. A goal of the course was to promote students' abilities to *use* learning-science concepts and theories to both analyze and design classroom instruction. A web-based environment was developed to support this course (Derry et al., 2005) and consists of three sets of tools: (1) an online PBL activity center in which students can engage in collaborative problem solving and discussion using a structured whiteboard and threaded discussion board; (2) an online hypertext book called the Knowledge Web, a collection of interconnected web pages dealing with learning-science concepts that students in the course use to conduct independent research; and (3) an online video library containing video cases of classroom instruction with links to relevant learning-science concepts in the Knowledge Web. Facilitators interact with students through a web interface that gives them access to all student work and activity.

Table 1 Collaborative steps of the PBL activity

Step	Tasks Involved	Step Goals
3	Join group.	Become familiar with group members, nominate minicases.
4	Select clips from video case to analyze; select concepts to utilize in analysis.	Narrow the scope of the analysis to a manageable piece of video (2 minicases) and reasonable number of concepts (3 Concepts).
5	Research concepts selected for analysis.	Become more knowledgeable about concepts chosen for the analysis.
6	Analyze the selected video segments using researched understanding.	Collaboratively investigate how the chosen learning-science concepts may be applied to the chosen minicases.
7	Construct the final analysis.	Synthesize group's research and discussion to produce an analysis of how the chosen learning-science concepts apply to the video case.

The PBL activity implemented for this study consisted of 12 steps, which, for research purposes, could be divided into two phases. The first phase of the activity (steps 1-8) required students to both individually and collaboratively analyze a video case of instruction, taking a learning-sciences perspective. The second phase of the activity (steps 9-12) required students to individually design lesson plans and justify them with learning-science concepts. It was intended that the video analysis portion of the activity in phase 1 would provide students with a rich understanding of a set of learning-science concepts they could use to help design their instruction in phase 2. Steps 3 through 7, described in Table 1 above, are the focus of the present study as they are where MD interacted with students and facilitated collaborative group activity on line. Students worked mostly individually on the activities that came before and after steps 3 through 7.

Methodology

Data Source

Two groups of five students worked with MD over a period of several weeks. MD was a teaching assistant who had some training and a little experience facilitating PBL in face-to-face settings, but he had not worked on line. The students were advanced undergraduate pre-service teachers majoring in secondary education and one in-service graduate-level teacher. The activity occurred completely online; students did not attend regular class meetings for the duration of the activity. The data for our analysis were collected from the threaded discussion board embedded within the instructional environment. This discussion board was the primary tool for communication. While email was also used as a method of communication, it was primarily a one-way channel that MD utilized to occasionally disseminate course announcements. The discourse that emerged on the discussion board provided a window into students' thinking and also into MD's facilitation and its influence on student thinking.

Analytical Framework

We adapted a framework for analyzing group discourse developed by Radinsky et al. (Radinsky, 2000; Radinsky, Liemberer & Gomez, 2000). Radinsky et al. aligned their model with the pedagogical theory of Dewey (1933) noting "Dewey placed reflection at the center of his model of teaching and learning, as a key piece of the process of making sense of experience" (p.9). In this framework reflection is defined as *purposeful thought or activity directed at making sense of "situations … containing a difficulty or perplexity"* (Dewey, 1933; quoted in Radinsky et al., 2000, p. 9). Reflectiveness is not seen as a momentary phenomenon, but rather as a dispositional and enduring characteristic of individuals that develops within activity systems.

Radinsky et al. developed their framework in the context of a middle school science classroom in which students collaboratively engaged in analysis of complex sets of geological data. In analyzing the data, students applied the conceptual knowledge of the domain to develop physical models (e.g., miniature tectonic plates) that explained patterns in the data. While this context is obviously different from the context of the present study, there were important similarities that justify our borrowing of their framework. First, the activities that Radinsky et al. analyzed were collaborative in nature; students engaged in complex problems and discussed their thinking during the activity. Second, the activity that Radinsky et al. studied required students to model complex data sets to learn course content. Similarly, the students in our study engaged in collaborative analysis of a video case of instruction using conceptual perspectives based on The Learning Sciences to explain and model cases. These video cases are essentially complex data sets that, within our course, must be parsed and modeled and interpreted using theoretical and conceptual lenses. This requires students to exert effort to make meaning and is essentially a reflective task.

Table 2 Components of Radinsky et al. (2000) analytical framework

Context	*Component*	*Description (Operational adaptations developed for this study)*
Data	Data Items	Reflection on specific items within the video data set.
	Data Patterns	Reflection on broader slices of video, described with broad characterizations; particular events are not mentioned.
	Real World Items	Reflection on real life examples from outside the data corpus.
	Domain Concepts	Reflection with concepts from learning-science curriculum of the course.
	Conceptual Models	Domain concepts are used to explain and analyze segments of the video and advance instructional design principles as causal models.
Task	Action Decisions	Reflection on how to proceed with the activity.
	Characterization of the Task	Reflection on general purpose or goal of task.
	Teacher Guidance	Reflection on the contributions and guidance provided by the facilitator.
	Artifacts and Tools	Reflection on what and how artifacts and tools are to be used in the activity.
	Group Norms	Reflection on how the group interacts to complete the activity.
Role	Student Identity	Discussion of or reflection on personal identity.
	Beliefs/Understandings	Reflection on current understanding or beliefs related to task.
	Prior Experience	Reflection incorporating prior experiences related to the task.
	Conception of Norms	Reflection on how individuals are to participate both socially and intellectually in the activity.
	Student Roles	Personal reflections on how one should participate.

Radinsky (2000; Radinsky et al., 2000) claimed there were three contexts in which reflection occurred during an instructional activity: data, task, and role. They described each as follows:

> The ‘data context’ is a representation of what we want students to think about and figure out: domain concepts, sets of data for them to study, the real-world items which data represent, and models representing all of these things. The 'task context' is a system of activity in which we hope this mode of thinking will develop, through instruction. The ‘role’ context is a system of individual factors which contribute to a student’s mode of participation in inquiry and other kinds of classroom activity. (p. 17)

Within each context were five components or topics for reflection, which are listed on the left side of Table 2.

Radinsky looked for changes in student reflection patterns across the three contexts over time, watching for a maturing of their “reflective dispositions for investigating complex data.” Within the context of our course focusing on collaboration, transfer and use of learning-science concepts in teaching practice, maturing patterns of reflection might include evidence of students' developing interest in self-directed learning about the subject, taking responsibility for their collaboration, or increasingly connecting the conceptual analyses required by their instructional activities to their real-world classroom experiences (they were simultaneously enrolled in a practicum). These dispositions would be manifested in our analyses as students' increasingly reflecting on particular elements within the data, task and role contexts in ways that suggest owning the task and connecting it to their lives.

Coding

To enable us to code our data using this framework, Radinsky's components were adapted and operationalized to fit our instructional context (see the right side of Table 2). Each component in Table 2 was considered a potential subject for student reflection. Online posts were coded to identify which subjects of reflection occurred. Below is an example in which a student's post contained a reflection on instructional guidance and a learning-science domain concept (modeling) after getting advice from MD about how to proceed with the activity. (In the example below teacher education students are viewing a video of a high school social studies class in which secondary students in the video are themselves engaging in PBL and in which the teacher in the video is modeling self-directed learning behaviors.)

> **[Student]:** As [MD] mentioned, PBL is new to this group of students (Code: INSTRUCTIONAL GUIDANCE) and I think that is key for recognizing the modeling (Code: DOMAIN CONCEPT) in this situation.

All data from the online posts during steps 3-7 of the online activity were coded. Coding reliability was calculated to be 85% (percentage of exact agreement) using two coders looking at 20% of the data. After coding, each discussion thread was analyzed in a process that involved mapping it onto a graphical representation of the Radinsky et al. framework (see Figure 1 below). The term "thread" refers to a series of posts that resulted from responses to a single post initiating a topic, which was usually done by the facilitator. Each line (labeled with participant initials and numbers representing order of post) in the map represented a student or facilitator post. The nodes connected by each line represent the components within the three contexts of reflection that a particular post addresses. Threads, which represented distinct phases within the activity, were analyzed with separate graphical representations.

Results

The collaborative video analysis activity was designed to have five online steps (steps 3-7, see Table 1). In step 3 the group logged on to the threaded discussion board for the first time to introduce themselves and nominate minicases (short segments within the video) to focus on for their analysis. In the fourth step of the activity, students were to reach consensus on two video segments ("minicases") to focus on as a group and on what "learning issues" (in PBL parlance), that is, what learning-science concepts, they wanted to further investigate in depth for use in their video analyses. In steps 5 and 6 they conducted individual research into learning-science concepts and brought their research back to online discussions of the minicases, sharing their knowledge in the process of collaborative analysis. Step seven was a deadline for submitting the final written analyses of the selected video minicases. In practice, the facilitated discussion threads did not follow these steps exactly; the groups and facilitator sometimes collapsed or altered the sequence slightly as required. The analysis reflected actual structure of the discussion as it unfolded rather than the precise structure of the activity.

In the following we report illustrative analyses for one group, illuminated by three "Radinsky Maps" and MD's reflections. The maps were selected to reveal trends in early, middle and late stages of the activity, offering a picture of how the collaboration evolved. The reflections offer explanations that connect facilitation decisions to the trajectory of the collaboration.

Three Radinsky Maps

<u>Introductions and Minicase Nomination Thread.</u>

MD began a thread on the discussion board with a post asking students to introduce themselves and to nominate two minicases for the group to analyze. Students responded by providing what they were asked for, introductions and minicase nominations. For example, one student posted:

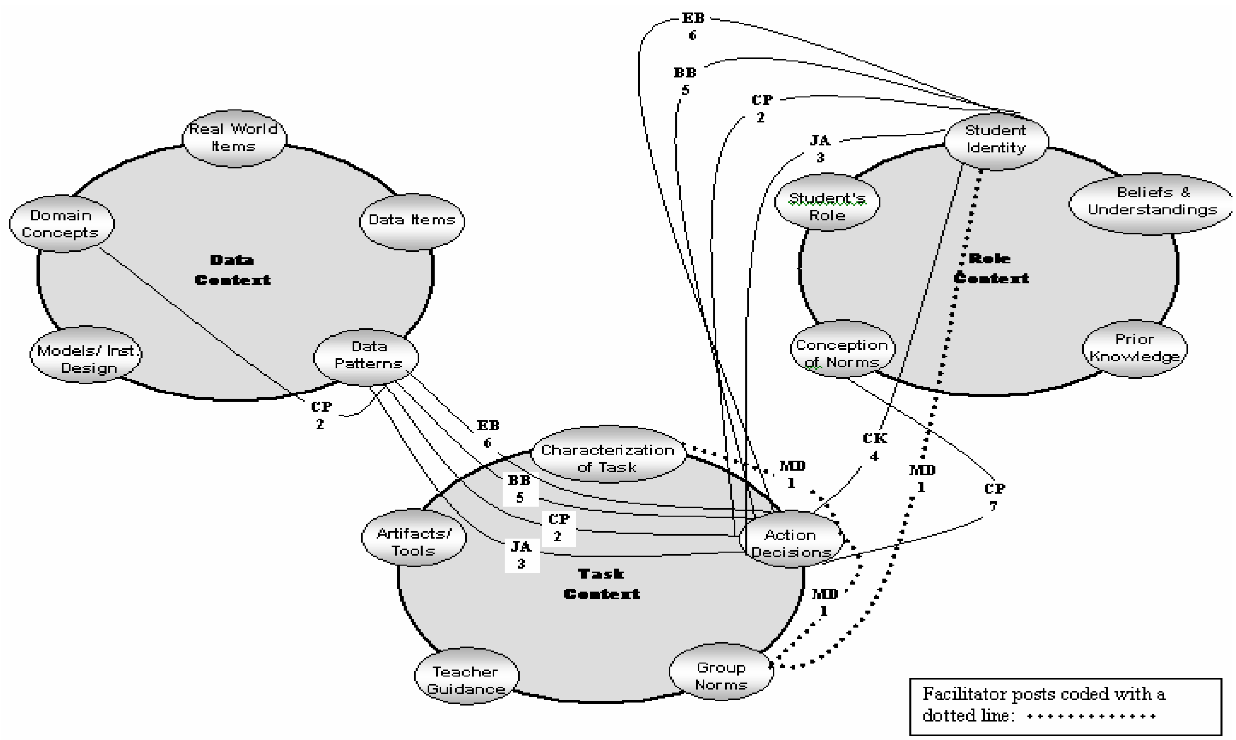
> **[CK]:** Hi everyone!! My name is ***, or ***, it doesn't really matter to me. Let's see, something interesting about me...I played tuba for four years in the UW Marching Band and marched at the Rose Bowl twice. I have already graduated once from the UW, with a double major in Animal Science and Ag Journalism. So, needless to say, it seems like I've been in school forever. Now, I am working on my dual certification in biology and agriscience. This summer I will be taking a grad class taught by my advisor in Australia. I nominated minicase 4 and 6 for the discussion. Look forward to working with everyone this semester.
>
> Other students posted similar introductions but adding further comments about minicases:
>
> **[JA]:** I really like case 8 because it shows what a student learned in participating in this activity. The student shows he knows two points on either side of the debate concerning school vouchers. I think that the case shows this student could reflect the results of the class. I like how it shows what the effort put into the activity produces

Introductions were slow coming in. Before they were complete MD pushed the group to move ahead and reach consensus on their minicases:

[MD]: Hi Everyone, To stay on schedule, we should move on to step 4 (choose which two minicases for the group to collaboratively analyze). I know that some of you haven't posted your introduction yet. Please post one if you haven't done so already. Basically what we need to do in this discussion is decide which two minicases are the most interesting and conceptually richest for discussion. Below I will summarize which minicases your group members nominated in their initial ideas assignment and their introductions. Let's use this as a starting point for discussion. What I need people to do is just jump in and start making arguments for why they think certain minicases should be the ones the group analyzes.

Please reply to this post with arguments for why certain minicases should be chosen. We need to choose these minicases fairly quickly to stay on schedule, so make sure you participate in this discussion.

The Radinsky Map for this segment looked as follows:



<u>Figure 1</u>. Analysis of Introductions/Selections Thread

As is shown in Figure 1, almost every post coded as reflection on student identity, action decisions (nominating a minicase), and data patterns (noting general characteristics of the minicases). Students nominated and gave reasons for particular minicases, but they did not debate which minicases were the best. Students made their indifference to this decision public:

[CP]: It may not seem like it, but it really doesn't matter to me which minicases we choose, as long as we get some deciding done and can get on with the whole process. This online discussion stuff is totally new to me and I'm hoping we can kick it into gear so we accomplish what we need to in a timely fashion.

CP's group members quickly echoed this post with similar sentiments.

MD Reflections on Introductions/Selection Thread.

Of the infinite ways a facilitator might introduce this activity MD chose this way for two reasons. First, the schedule was unforgiving. Second, this was the first time the students had worked in this online environment and with each other; some confusion and disorientation were expected. It thus seemed necessary to proceduralize the early part of the activity for efficiency, delaying more complex negotiations until later. So instead of problematizing this stage of the activity, to facilitate their entry he chose a proactive form of facilitation that tended to lead more than guide. In his journal MD wrote: "At this point, I envision myself being the person that blazes the path for others to follow. I want to create structure to this impersonal online environment." The students obliged by following MD's instructions.

One effect of this strategy appeared to be that students did not experience ownership of the problem. Nor did they experience a strong sense of “difficulty or perplexity” that might have promoted more reflection. At this stage of the problem there were several facets of the activity that could have been problematized by students. For example, the negotiation of the procedure for picking two minicases could have been subject to discussion. Later, at the time of MD's prompting of students to move ahead, it was becoming apparent that to stay on schedule the subtasks of the activity would need to be completed rapidly. While this post made clear that argument was expected, the criteria by which students were supposed to select and evaluate a minicase were left vague and subjective, although these too could have been problematized for negotiation.

MD's concern for the schedule and awareness that students needed logistical support may have contributed to a sparse and narrow reflection pattern. A reflective pattern in which students considered other issues such as group norms, participation norms, and characterizing the activity in a personally meaningful way might have occurred if there were a higher level of student ownership of the activity (Engle & Conant, 2002) and a sense of a compelling problem (Radinsky et al., 2000).

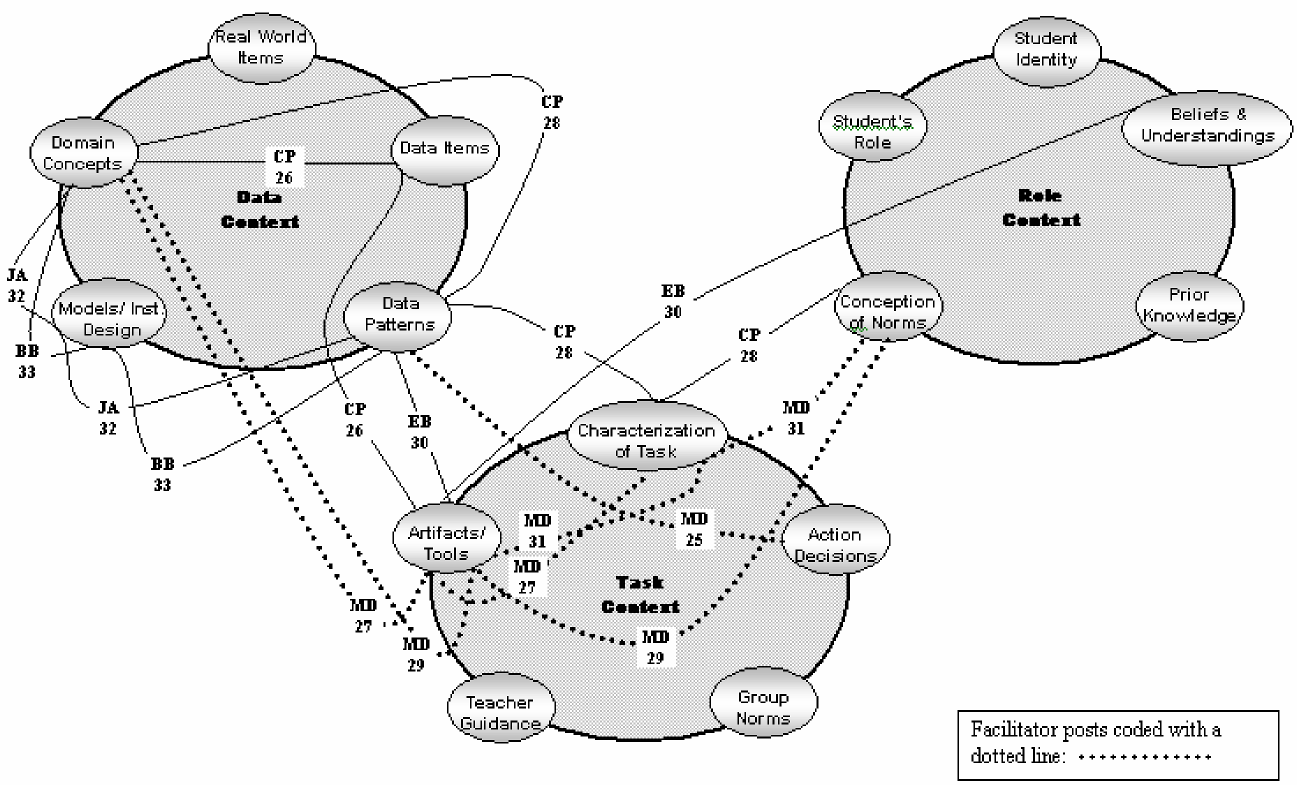


Figure 2. Concept Selection Thread

Concept Selection Thread (Step 4 Continued)

The task related to this thread was to select concepts that were likely to be keys to analyses of selected minicases and on which students would conduct research (the last of step 4 of the activity structure). Again, MD took the lead in beginning this thread with the following post asking students to share their ideas:

> **[MD]:** In this thread we will discuss what the relevant learning science concepts for minicase 8 are. In the previous discussion, some of you mentioned that this minicase shows what people learned from this lesson, what we might call learning outcomes. What other learning science concepts seem to be at play here?

As reflected in Figure 2, students are evolving their collaboration toward focus on the data context, specifically domain concepts, data patterns, and models, essentially sharing as individuals what potential learning-sciences concepts were "liked" or "seemed interesting" for analyzing chosen minicases. For example, JA posted:

> **[JA]:** In case 8 I like the concept of questioning. I think the way a teacher asks questions can make all the difference in a discussion and can make them elaborate when a two word reply would do otherwise. I think in the case you can see how the teachers questioning asks for both sides of the issue showing a neutral stance and just taking in all the research and again modeling appropriate behavior. So I think that the concepts I see for 8 are questioning and modeling.

MD Reflections on Concept Selection Thread.

Similar to MD's introductory post, this introductory post was essentially a short-answer question that requested information and gave no indication that this step should be problematized. A discourse pattern emerged in which students followed the facilitator's lead and did not display much agency in directing the activity or discourse. As is shown in Figure 2, the nexus of students' reflective discourse is in the process of moving into the data context. While there are posts that reference the task context, and to a lesser extent the role context, the majority of these were MD's. In these posts, MD characterized the task *for* the students and clarified how to use the tools. On these issues, students followed MD's lead. Moreover, they did not challenge or question one another's ideas, which might have fostered more reflection. This may be due to students interpreting the task set for them as one in which they find "interesting" ideas to research; hence it would make no sense to engage in controversy.

Collaborative Analysis: Research and Analyze (steps 5 and 6)

During steps five and six of the collaborative analysis, students began researching the concepts that they selected in the previous step of the activity and using them to analyze the minicases they selected. Figure 3 shows the graphical representation of one of the two threads in which students discussed their analyses. Each thread focused on one minicase analysis. Only one thread map is shown due to space limitations, but both maps are virtually identical.

As shown in Figure 3, students' reflective talk did make important connections among data patterns, domain concepts and instructional design models. An example from CK:

> **[CK]:** While there are many forms of assessment, Kyle chose a form of Authentic Assessment for measuring the progress of his students. Authentic Assessment is used when traditional methods are judged too narrow in determining the actual cognitive outcome. In this case Kyle used Performance Testing, or testing where students create a tangible product as a way to show their understanding of a subject matter. He also appeared to be assessing the students by asking them about the opinions they had developed. . . . Authentic Assessment . . . helps students develop a variety of skills instead of just the ability to regurgitate facts presented to them by the teacher.

To which MD responded:

> **[MD]:** I like the point that [CK] has made about authentic assessment. We were able to glimpse at the form of assessment that Kyle was using in this minicase. As [CK] points out, it seemed more authentic than a more objective assessment might seem. How might we use the concept of transfer to better understand this

assessment? What exactly might the "letter to the president" assessment be testing?

MD noted in his journal: "Because they are all doing their own research, they don't seem to be interested in questioning the research that others are doing."

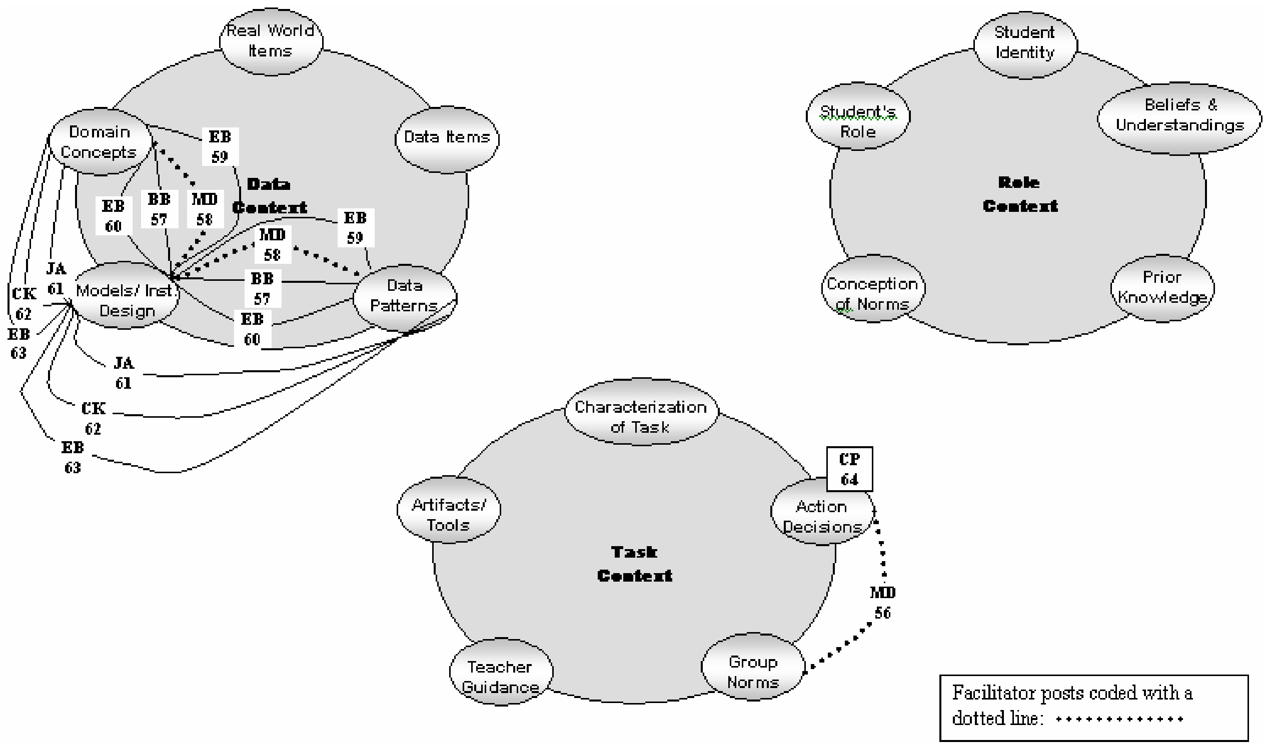


Figure 3. Conceptual Analysis Thread

MD Reflections on Conceptual Analysis Thread.

From the beginning MD had looked forward to steps 5 and 6 (the research and analyses steps) as having greater potential than earlier phases of the activity to support meaningful discussion. In these threads students did in fact begin to connect domain concepts and data patterns to build plausible complex models of instruction informed by learning-science concepts, which was an important instructional goal. This was viewed as a partial success for this phase of the activity. In addition, MD noted that his questioning strategies had evolved from primarily short-answer questions to long-answer questions. Nevertheless, *discussion* was not rich as students did not often challenge one another, which limited their need to reflect further on what they posted. Moreover, their evolved reflection patterns became even more narrowed and focused, failing to cover much range even within the data context: there were no connections at all to real-world or personal experiences, for example. Nor did they reflect on any components within other contexts of reflection (task and role). MD concluded that the pattern of explicit leadership he had demonstrated up to this point, along with the emphasized importance of sticking to the schedule and failure to set norms for problemitizing issues early in the task, likely hampered students from questioning one another.

Discussion

MD's strategy constrained students' involvement in the decision-making process early in the activity, which likely produced the narrow and relatively shallow reflection patterns that evolved in this study. In contrast to the patterns of questioning that Hmelo-Silver (2003) found an expert facilitator demonstrated, MD observed that his early questioning strategy employed mostly short-answer questions. Also missing from his repertoire were task-oriented questions that would push students to think beyond the domain content of the problem to question the nature of the problem and determine what process would be used to investigate it. However, multiple factors that seemed to be at play need to be considered and are discussed below.

First, the strategy that MD employed was successful on several levels. Students participated at persistent levels throughout the activity. Trial runs were performed on the system prior to this implementation revealing that (1) participation could not be taken for granted, it needed to be prompted; and (2) logistically complex activities can quickly result in confusion, lowering participation. In conquering these issues, MD used a strategy that essentially removed all logistical responsibilities from students early in the activity, in order to avoid the confusion and slowness that plagued trial runs of the system. As a result, in addition to participating and completing the activity, students were more focused on the content of the problem rather than logistics, as evidenced by their evolved reflection pattern within the data context in steps five and six. This created tradeoffs in that valuable aspects of the activity were sacrificed for the sake of getting it done. Such tradeoffs are ubiquitous in teaching (e.g., Leonard & Derry, 2006), but they are problematic.

The patterns uncovered in this analysis showed two things. First, students were highly focused on the paths that MD blazed for them: students closely followed instructions both in what they produced, but also in what they thought about, primarily domain concepts, data patterns, and models. Second, students did not reflect much within the task and role contexts proposed by Radinsky. This led us to question whether it is necessary to reflect on these contexts.

MD's strategy of carrying the logistical load during the early activity was implicitly based upon his initial assumption that these logistics were not related to the intended learning goals. But this analysis confirms in our minds that this was a flawed assumption. Engle and Conant (2002) argued that in order for students to productively engage in a discipline, they need to be presented with intellectual problems in a manner that will provide them with the *authority* to frame and solve problems. Not ceding this aspect of the activity to students runs counter to strategies of successful facilitators (Frederiksen, 1999; Hmelo-Silver, 2003; Palincsar, 1999). The fact that students generally did not reflect on the task and role contexts suggests that students did not perceive themselves as owning the problem and hence they were not highly invested in or motivated by it. Students were not questioning or negotiating process or their own participation. Students did not argue (or care?) about what could serve as evidence that a particular learning-science concept was relevant or appropriate in a particular situation. And despite the course's focus on transfer, students never reflected on the relationship of their coursework to their teaching experiences or lives. It is possible to see this problem in another light as well: Researchers are recently writing about the importance of developing students' 21st century "soft skills" (e.g., Bereiter & Scardamalia, 2006). Such skills include communication, leadership and collaborative competencies that would likely be developed through reflective engagement in the task and role contexts.

The current study was a proof of concept that the Radinsky et al. framework can be generalized to an online instructional context in a very different domain and for a different purpose: supporting and organizing the reflective thinking of new online facilitators. For this we found the framework useful and reasonably efficient. The method had limits however. For example, it depicted the target and content of thought, but does not of itself reveal much about functional discourse strategies, which might be fostered through facilitation to promote greater reflectivity in groups. Moreover, we found ourselves questioning where reflectivity ended and 'plain thinking' began, and whether one statement was more or less reflective than the other. We resolved this temporarily with the assumption that public discourse in a PBL context is nearly always a form of reflection, although we are not satisfied with that answer.

It is also necessary to ask the extent to which the tools and technologies employed in the instruction imposed constraints on the instructional process, the facilitator, and students. MD's journal reflects numerous frustrations with limits of the technology, and we readily acknowledge that these exist. It is always likely that a better chat environment, interface, instructional design, or Internet service could make a big difference. It is possible that such technologies set a theoretical limit on performance that partially determines the effectiveness of PBL instruction. However, we sense that facilitators can make a huge difference in any environment, regardless of its design strengths and flaws. With this study we benefit from the learning and shared experiences of a brave facilitator.

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