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Task Structuring for On-line Problem Based Learning: A Case Study

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ABSTRACT

Getting students to collaborate on group projects in a face-to-face scenario can be difficult enough -- but how does one approach collaborative projects in a Web-based environment? This article explores the story of one course that used asynchronous Web-based conferencing software to mediate the group process in a problem-based learning scenario. Through careful planning, assignment structure, and facilitation, this project became a success (based on comparison with previous semesters' projects, student comments and instructor's reflections). Finally, resulting from this case are suggestions that other instructors and instructional designers might use in creating their own on-line group project spaces.

Keywords: Problem-based learning, Web-based conferencing, Collaborative learning group, Online learning, Task structure

Introduction

Problem based learning (PBL), collaborative learning, and online learning tools all are popular topics in education today. Each holds the possibility of promoting active, authentic learning situations. But what happens when all three are combined? And how does an instructor organize and facilitate online problem-solving groups? This article explores the story of one course that used asynchronous Web-based conferencing software to mediate the group process in a problem-based learning scenario. In particular, it focuses on how student tasks were designed, structured, and presented, and the resulting effect on learning outcomes.

Instructors who assign group projects often face dilemmas such as how to know who is actively contributing to the assignment and how to make sure that all students have the opportunity for substantive input. An on-line collaborative learning environment was deemed an appropriate was of facilitating group projects by the instructor for three reasons. First, it was a way of extending the students' growing computer skills and literacy. Second, it provided a glimpse of yet another technology that could be used for learning. Third, and perhaps most importantly, the instructor recognized that it held the potential for promoting more collaborative and successful group projects.

Collaborative learning is a process that involves interaction amongst individuals in a learning situation. It is rooted in a theory of learning the focuses on social interaction as a way of building knowledge (Gerlach, 1994). Through collaboration and socialization students must listen, articulate, clarify and negotiate in their quest to create meaning. In terms of learning goals, collaborative learning can be used to foster critical thinking skills and frequently is present when students are asked to do reasoning or problem-solving tasks. Nelson (1994) suggests that there are three major success factors that are determined by the teacher when collaborative learning is used, namely preparation, cognitive structuring, and role structuring.

Problem-based learning involves the use of authentic problems and materials for learning; students in a PBL environment are tasked with applying their knowledge toward developing solutions. Problem solving activities give students the opportunity to learn from authentic scenarios and actively engage in the use of higher order thinking skills as per Bloom's taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). In other words, a PBL scenario assesses student performance on tasks that go beyond requiring just knowledge, comprehension, and application, and that involve demonstration of analysis, synthesis, and evaluation, all of which are more complex abilities. Students must define these problems before they may solve them, and typically there is no set solution. Often PBL is used in professional and pre-professional education, placing students in real-world scenarios as a practice for the authentic situation. As a result, both process and product tend to be valued and assessed.

Problem-based learning does not inherently involve collaborative learning, and vice versa, although frequently the two are used together. The two are used together well when the learning involves heuristic tasks, conceptual understanding and/or cognitive strategies (Nelson, 1999). This method of teaching not only prepare students for future problems they might face, but also encourages interaction and the building of interdependent knowledge communities (Bielaczyc & Collins, 1999). Reigeluth and Moore (1999) suggest that PBL involves both a "problem space" and an "instructional space"; in other words, learners must both acquire the requisite knowledge and then solve the problem. It is the teacher or instructional designer's job to develop these "spaces" for the learners.

While the instructional design and organization required to create a collaborative learning or problem-based learning project may be challenging enough on its own, adding computers into the learning situation holds as much challenge as it does promise. Teachers must struggle with new ways of structuring their collaborative learning assignments when they put them online (Sullivan, 1994). Koschmann (1996b) recommends, however, that computers are useful tools for facilitating students collaboration and learning. As a collaborative problem solving tool, computers can be used to present data to students and guide them through their decision-making process (Schank, Berman, & Macpherson, 1999), to help students store and organize their data (Koschmann, Kelson, Feltovich, & Barrows, 1996a), and to document and archive their process, decision and findings (Schwartz, Lin, Brophy, & Bransford, 1999). All of this is in addition to facilitating communication among students.

Winn (1992) promotes the idea that computer-based communication tools should be treated as empty shells created or facilitated by teachers but to be filled by learners. Given such a scenario, the focus of instructional design for a learning activity using a Web-based communication tool should be activity and message design rather than just content design. Applied to a Web-based conferencing environment this proposition suggests creating an environment in which students can be actively engaged in the process of developing knowledge rather than one in which all of the knowledge is presented via written documents such as lecture notes. This viewpoint works well with the concept of collaborative problem based learning which engages students in a process involving exploration and decision making.

Background and Rationale

In the class being studied, the instructor decided to take her regular collaborative problem-based learning projects and facilitate them through a Web-based conferencing (WBC) tool. Although the class had 3 live sessions each week, the instructor felt frustrated with the way these projects had been facilitated in the past. Students did little to document their work processes, and it was difficult for the instructor to monitor all groups at once. Significant in-class work time was needed to help the instructor assess which groups needed assistance and which group members were contributing their fair share. She also noted a tendency of students to put off serious project work until the last minute and to let one dominant student take over the project idea and execution.

The class was already using a Web-based conferencing tool for class discussion; this tool had been adopted because the classroom environment (a computer lab) and size (30 students) were not optimal for an in-class discussion. With 30 students, not everyone had an opportunity to speak and the computers were a strong distraction for students. Additionally, the layout of the room with rows of monitors facing forward and the sound of the computer stations' electronic hum made it difficult to hold a discussion in which all speech was audible and everyone could see the person who was talking.

The decision to use the WBC tool to mediate, at least in part, collaborative problem-based learning assignments was based on a few factors. First, the instructor had noted that students often had difficulty finding time to meet outside of class to complete group projects. Second, the instructor felt that from previous semesters using a WBC tool that students working on group projects would appreciate the way their work would be documented in the conference, providing a sense of accountability for all group members. Finally, the instructor wanted to maintain constant use of the tool so that students did not forget how to use it between online class discussions which occurred only periodically during the semester.

Methodology

In this case study observations, documents and questionnaires were used to collect data that would tell the story of how problem based learning, collaborative learning groups, and Web-based conferencing were being used by these educational computing students. Students were observed both in class and online, and completed an evaluation questionnaire about the problem-based learning projects at the end of the semester. The course syllabus, teaching materials, and the instructor's notes and reflection journal all were collected. Student projects and presentations, which were available to the whole class for peer critique, also were reviewed.

Data from each of the three different PBL projects were analyzed separately, with a cross-project analysis at the end. Within the analysis of each project, the work processes and outcomes of different collaborative learning groups were examined.

Description of Study Participants and Setting

Students in this study were pre-service teachers in two sections of an undergraduate educational computing course at a large state university. Both sections of the course were taught by the same instructor and utilized the same learning materials.

In addition to their regular projects and papers, students in these classes each worked on three different problem-solving projects in collaborative learning groups. An online tool was available and at times mandated for student use on the projects. Each time the task and instructor directions were slightly different.

In this educational computing course students were required not only learn to computer applications, but also to integrate them in simulated teaching scenarios. Students taking this course are generally in their first year of college study and, although they plan to become teachers, typically do not think of themselves as members in a community of teachers. They approach their learning in a solitary manner.

The instructor had prior experience with the online course tool and had used the PBL group projects once before. The Web-based conferencing tool, Alta Vista Forum (now SiteScape Forum), allowed for threaded asynchronous discussion, link sharing, and document sharing. Project groups were given team spaces that could be accessed only by group members and the instructor.

Description of Assignments and Task Structuring

Technical Preparation and Group Formation

Students were prepared to use the Web conferencing tool through earlier in-class work and online discussion assignments. At the beginning of the semester, the conferencing tool was introduced to the class and free discussion was encouraged. All students submitted an introduction and a few replies to their classmates. A small-group discussion assignment followed in which students depended on each other's contributions in order to be able to further the conversation and thus meet the assignment completion goals. At the time that the first PBL project was introduced the students had used the Web conference for four weeks and were exhibiting a general understanding of how to send messages. About one quarter of the students were still having difficulty with threading their discussions at that time, which is evidenced by multiple one-message threads that, when strung together, form the thread of a single discussion.

Students were not required to do their entire projects using the WBC tool, but they were required to at least document their group's process and work via the tool. Certain parts of the project, such as brainstorming and idea generation activities, were required to be done using the conference so the instructor could assess both overall group progress and individual student contributions.

The guidelines for the three projects gradually became more specific and structured; the third project was significantly more structured in terms of tasks to be completed and their deadlines than the first project. The instructor made the decision to continue adding structural elements to the assignments as she viewed the students at work.

Problem One

For the first problem, students were placed in randomly assigned groups and given the problem, a list of deliverables, and a due date. Work division and patterns were left up to the individual students in each group. The basic structure of the assignment, as given to students, is included in Table 1. See the appendix for a sample problem statement that was presented to students.

Day	Event/Task to Complete
Day One	Assignment Given, Groups Formed
Day Fourteen	Assignment Due

Table 1. Problem One Structure

Problem Two

For the second problem, students were again placed in random groups. The groups were shifted around so that students were not working with the same people they had worked with during the first project. This time students were given multiple tasks, both individual and group-based, with an overall deadline, but interim deadlines as well. In this case, the individual work was completed first, and then students had to share their work, give each other feedback, and compile their work into a larger group project (see Table 2).

Day	Event/Task to Complete
Day One	Assignment Given, Groups Formed

Day Seven	Individual Work Due
Day Ten	Provide Feedback on Individual Work
Day Fourteen	Full Group Assignment Due

Table 2. Problem Two Structure

Problem Three

The third project was the most structured of the three. Although specific student interactions were not micro-managed, certainly the timeline was, giving students several small tasks to be done at particular times over the two-week project period. For this project students were grouped by the instructor according to interest because this was an assignment that was very rooted in application of the course content to different professional areas.

Day	**Event/Task to Complete**
Day One	Assignment Given, Groups Formed
Day Three	Summarize and Present an Article to Group
Days Five	Present a Project Idea to Group
Days Five - Seven	Brainstorm with Group, Select Project Idea
Day Twelve	Draft Due
Day Fourteen	Full Group Assignment Due

Table 3. Problem Three Structure

Results

Problem One

Students seemed initially overwhelmed by this project. During the class period when the problem was assigned, students had time to work in their groups. Most groups sat idle until the instructor came and checked on their progress, at which time some groups outright asked questions like "What are we supposed to be doing?" while others waited to be asked if they needed help.

One project group made extensive use of their WBC forum for this project, using it to develop their concept and collaboratively make decisions and write up their project. One could clearly see their group process by looking at their conferencing area. At the other end of the spectrum was a group that had only four messages posted in their forum. Their messages read as follows:

> **Message 1 (Day Two, "Amy"):** Hi team, is anyone out there? Well, see you in class.
>
> **Message 2 (Day Three, "Mike"):** Hi "Amy"! I am going away for the weekend so I can't work.
>
> **Message 3 (Day Eleven, "Lisa"):** Don't forget to bring your draft to class tomorrow. We really need to start putting it together.
>
> **Message 4 (Day Thirteen, "Amy"):** Here it is! Let me know if there are any changes. [attached file]

Most groups used their conference to exchange files, and seemed to have a designated "project compiler" who assembled all of the parts on the last day. While there is some indication that in every group at least one student tried to use the forum to communicate with their group, such messages generally lacked focus and were not responded to substantively or at all by classmates. The message example above, from "Amy" is an example of one such message. Even students who attempted more directed engagement with their group members, such as "Paul" who wrote "I think we have a lot of good ideas. But more important we need to get this done. Let's just pick something," received little response from their teammates, who did not log in to the WBC tool often during week one. As the due date neared, online interaction for all but one group (the example given above) increased; this interaction was focused on completing the project.

Problem Two

For the second problem, students were required to use their group conference area at least three times. There was a tendency for students to wait and post their messages or assignment right at the deadline, which seemed to squash interaction among teammates in some groups. The nature of student messages in teams where everyone was posting at the deadline was rather perfunctory; students appeared to be working toward satisfying the project requirements. The tone of the messages similarly seemed to acknowledge that the team was not the only audience; there was a general awareness that the instructor would be monitoring and assessing student contributions and progress throughout the project period. Students who missed the deadlines entered their assignments late and often with verbal apologies and excuses. In general, the deadlines and structure in this project seemed to foster a greater sense of within-group and self responsibility.

The project teams, which were different from the project one groups, still varied in terms of amount and quality of participation. Some groups seemed to gain momentum after the first (individual) task deadline; however, half-of the project period was over by the time that this deadline arrived at which point many students began to focus on and worry about solving the problem and completing the project on time.

Technical problems like inability to attach files correctly or post to the correct discussion thread were not present during this problem; clearly students had gained sufficient experience using the tool in their online discussions and during Problem One. Group processes and individual contributions were largely evident in what was posted to the group discussion areas. The same students who were active online were the students who were active when the groups worked together during class time.

Problem Three

Problem Three was highly structured both in terms of what students were to do and when they were to do it. The instructor organized the idea generation process for students, giving them concrete tasks like reading and summarizing a relevant article and proposing an idea to the group. The decision to include these requirements was based on the instructor's desire to see more of the student problem solving process and to create higher stakes for active team collaboration. Non-participating students had conspicuous absences during this problem since much of the problem solving process had to be documented through WBC participation.

Teams appeared to work steadily toward their solution throughout this two-week problem period; most teams had a near-final version of their project posted by the time the draft was due. Team members who were not fully present found that they could catch up with what the group had done rather easily, but also seemed uncomfortable with the amount of work that was completed so visibly without them. To quote the message of perhaps the most frustrated student in this situation, "Hey, this looks almost done. You guys have to give me something to do. I promise I'll do it on time, but I have to do something for the project. I need this grade, so I have to do it. Just tell me what you haven't done yet."

Student and Instructor Feedback

Both students and the instructor indicated that they preferred the third problem to the first two. Students stated that problem three went smoother for reasons such as "we knew what we were doing by then," "the project guidelines were much clearer than [the guidelines for problems] one and two," and "you really couldn't slack off so you had to get it done on time." The instructor stated that she preferred problem three because students had no choice but to document their problem solving process. She felt more assured that students understood the task at hand during the project period and more confident confronting students who were not participating. It had been her initial hope that students would use the conference more than they had during the first two problems; however, when asked informally about why they did not use the conference more while working on those problems students stated that they had been uncertain how it might benefit their group process and they felt uneasy about posting messages when they did not know if anyone else would bother to read them.

Discussion and Conclusions

There was a clear improvement in student performance, both in terms of process and in terms of product, over the course of the three projects. Some of this improvement is likely attributable to student familiarity with the course content, the WBC tool, and the instructor's expectations. However, it seems probable that the increased task structuring, which students indicated provided them with extrinsic motivation and task clarity, also affected their performance and outcomes during Problem Three. Certainly the accountability factor created by having an archived document of group interactions prompted some students to be more conscientious and punctual than usual in their participation.

Specific tasks were found to be important to promote on-line collaboration, particularly at the onset of the assignment, because students were often reluctant to otherwise be the first person to post. When students felt supported by the assignment requirements ("I'm doing this because I was told to do it") they felt more comfortable to initiate participation. In other words, students wanted someone else to tell them where to begin.

Participation time frames were found to be important because students were relying on each other to complete parts of the assignment. When left to manage their online time themselves, procrastinators from previous semesters of the course would not enter the group project space until close to the due date; by that time they had missed the opportunity to shape the content of the project. With specific guidelines such as "Post your project idea by {day}; Post feedback to each team member's idea by {day}" students had a clear idea of how to work project time into their schedule and knew when to expect.

Finally, the combination of group and individual work in these assignments gave students an element of control over their own grades. Many students expressed concerns about doing group projects because they feared having to do all of the work themselves in the interest of completing the assignment on time at an adequate quality level. Having some aspects of the project to complete and be graded on individually helped these students feel more secure that the instructor would recognize the effort and learning that they demonstrated.

Over the course of the semester, the instructor moved from less structured to more structured tasks for her students as they worked through the various problems. This approach of moving from less structure to more may seem unconventional, and it should be noted that this approach had not been intentional at the beginning of the course. Instead, the instructor modified her assignment plans between problems based on the students' reactions. Each time she added structure it was because she felt that student performance on the previous problem had indicated a need for more structure in this area. Essentially, the instructor felt she had learned of the need for task structuring over the course of the semester and made plans to implement the additional structure throughout the course the next time she taught it. It also should be noted that with each subsequent project students became more and more familiar with the process and expectations.

In closing, the instructor of this course realized more success in terms of quality and timeliness of student work as well as group collaboration when online conferencing and highly structured assignment parameters were used in problem-based learning. It might be argued that the additional task structuring and deadlines used in Problem Three detracted from the authenticity of the collaborative and problem solving processes. However it should be noted that students were not given any guidance in actually solving the problem; instead they were provided with general process tasks and time frames. In some real-world problem solving scenarios people are presented with steps or tasks and incremental deliverables too. Not all problems lack structural or procedural guidelines, and such guidelines do not on their own provide the solution for students. Indeed, some level of task structuring and expectations is important for teaching students about problem-solving processes.

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Appendix

Problem Statement

This problem statement was given to students in the form of a memo from the principal, presuming that they were teachers serving on the school's technology committee who were being called up on to determine how the school might distribute its new equipment in a way that best met the school's needs and that made sense pedagogically.

Students were also provided with documents such as school blueprints and listings of numbers of teachers and students at each level to assist in understanding the school's physical constraints and needs.

From: Mary Smythe, Principal, Eagle Summit School

To: Technology Committee Members of Eagle Summit School

Subject: Technology Allocation Plan

As you know, our school has been awarded a retrofit grant through the Department of Education to help us to upgrade our school's technology. The equipment which our school will be receiving includes:

60 computers

12 printers

3 scanners

1 digital camera

6 projectors

As members of the school's Technology Committee, you will need to develop a Technology Allocation Plan. You will need to research the best ways to distribute the equipment throughout the school building. You do not, however, need to include cabling, etc. specifics since the district technology specialists are responsible for such concerns. Your completed plan will be distributed to the District Technology Office for approval. The committee's

Technology Allocation Plan must include the following components:

1.a blueprint of the school with equipment allocations listed (either in computer labs, computer clusters, or distributed throughout the classrooms)

2.a list of the equipment which will be available for checkout through the media center

3.a 1.5-2.5 page paper which justifies the allocation of equipment (including citations to the current research)

Remember that your plan should take into account the needs of our unique school setting. I look forward to seeing your plan.
