PEDAGOGY OF ONLINE MATHEMATICS LEARNING: CASE OF WEBCT IN A MATRIX AND A RESEARCH MATHEMATICS COURSE

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Introduction

Advanced computer technologies have been taking the role of classrooms at an increasing pace. There is already a growing body of literature that supports and believes in the use of the emerging technologies for the purpose of teaching and learning (Beevers and Paterson, 2003; Wolf, 1988). For instance, Piaget and others (Forman and Pufall, 1988; Wolf, 1988) trust in the potential of the instructional technologies in cognition in the sense that they can provide interaction, the intense pursuit of knowledge through action on experiments with material objects as well as thoughts about those objects. Wolf (1988) adds, "Computers are only as promising as our ability to realize engaging and demanding interactions through them" (p. 213). Thus, socialized constructivist learning environments can be established through communication tools provided by course management/delivery systems such as WebCT and Blackboard (Luca and McLoughlin, 2004). Consequently however, the mounting use of technology for the purpose of providing socialized learning environments has resulted in a need for a shift in our pedagogy of teaching and learning mathematics. In addition to the course material delivery, now instructors need to consider the pedagogical and organizational issues of online teaching and learning. How would one design and control the organization and dynamics of the online course environments to provide effective learning?

It takes an informed instructor to take into account the pedagogical and organizational issues that occur due to the nature of the technology based-learning environments. This paper attempts to inform the instructors of mathematics of various pedagogical and organizational aspects of online learning environments. The readers will consider the similarities and differences of the two evolving learning environments designed for mathematics courses with differing cognitive demands; a matrix algebra (math3323) and a research methods course (math5360) supported by the WebCT course management system. WebCT is provided by the University of Texas at El Paso (UTEP) to support undergraduate teaching and learning. It consists of various instructional means such as discussion board, e-mail, whiteboard and assessment tools. Instructors have freedom to organize the tools according to theirs and students' teaching and learning needs, and they have a designer option to control student access to various tools and sites. That is, instructors can make online discussions private between the students or between a student and an instructor.

Organization of Websites

As WebCT was integrated into the courses, it became evident that students were not familiar and comfortable with the technology and its set up. They had strong preconceived notions about the organization of the course sites. Hence, they persisted on using the online tools and searching information accordingly. This lead to confusion resulting in increased frustration. It became necessary to reorganize and customize the websites (Mabrouk, 2002; Marinas, 2002). The remainder of the paper introduces the online course sites, specifically the communication tools (e-mail and discussion forum), and discusses how the organization of these tools evolved to maximize interaction between students and teachers.

Table 1. The number and the frequency of e-mail postings.

	Math5360 (N=22)	**Math3323(N=45)**
Total number*	**29**	**103**
Frequency (*/N)	**1.3**	**2.3**

E-mail

E-mail was mainly used as a communication tool between the students and the instructor. The instructor used it to inform students of changes, and to provide hints and guidance for the students' questions posed online. There were a noticeable number of matrix algebra students who used e-mail to ask questions and request feedback on assignments. There was also a quite a bit e-mail traffic in the research course (see Table 1). Students in both courses used e-mail more often than the number of office visits they made. It appears to have been very convenient and less intimidating for them to drop a question via e-mail to the instructor while working on the assignments. Students indicated, on their end of semester online reflection of the course, that they did not have to wait for the office hour or the next class meeting to see the instructor to communicate their ideas and questions, they could send an e-mail right then at that moment. The instructor checked e-mails at least twice a day (early in mornings and late afternoons) and made the effort to provide feedback. This allowed students to receive in-time feedback while questions were fresh in their mind, which lowered the level of frustration, and as a result many students stayed with problems longer. This provided more time for students to participate in quality discussions on their approaches and solutions. In other words, e-mail provided the instant guidance and social interaction that students needed for meaningful learning.

E-mail did not require very many adjustments on its organization. There were little to no report of problems with the default organization of the e-mail option that includes mainly the "Inbox," "Outbox" and "Draft" options. Students initially however had some difficulty with the editing option. Some of the obstacles were those with the file attachment and the equation editor. Fortunately, after a short introduction to these components, many of the problems diminished. Even though there were a few more

options added to the e-mail forum to help the instructor store and find information faster, students did not buy into the new additions. They preferred and continued to use the default setting. The instructor did not do anything to encourage students to use the added sections partly because he/she did not feel that it was causing major difficulties in finding and responding to students' e-mail postings. This suggests that the default e-mail forum may be sufficient for effective communication.

Discussion Board

The discussion Board was used for students mainly to post reflections on activities and assignments. Students were expected to read classmates' reflections in advance, and be ready for the upcoming classroom discussions. In the research course the discussion forum was used to post reflections on articles, textbook readings and assignments, and to place reactions to the posted reflections. This however caused a challenge for the students and the instructor. There had been postings all over the board making it harder to keep track of the messages, which led to increased frustration among students. It was becoming evident that reading and assessing reflections and reactions before the class meetings was becoming almost impossible. This was in part due to the lack of a more efficient organization of the Discussion Board. The instructor needed to reorganize the board to provide a more effective approach that would help with placing and finding postings. Consequently, the discussion forum was reorganized according to class assignments mainly based on the instructors' observations. Students, however, had different ideas to how the board needed to be organized. They were spending so much time in attempting to make sense of the logic (the instructor's logic) used in the redesigning of the discussion forum that there were either many messages placed on wrong files or random postings anywhere and everywhere on the board, which again led to confusion and difficulties with locating and assessing students' work in time for classroom discussions. In-class discussions with the students led to students' direct involvement in restructuring taking into account the instructor's need, which resulted in a customized and more efficient organization of the tool. Figure 1 shows the final product of the student-involved design of the discussion forum. This design first divides the board according to group assignments, and next includes files on each group folder for class assignments. Afterward, there were not very many students encountering problems with the Discussion Board.

One last issue that needed to be dealt with however was with the way students were placing new messages under each assignment. They had to be reminded to add new postings, in the corresponding assignment folders, as responses to their last postings. In this way, the process of finding students' online work became more systemic hence requiring less time to assess. That is, it became easier to keep track of individuals' online activities. For instance, if the instructor wanted to find student A's reflection of a most recent article, all he/she needed to do was first to get to the group folder where student A was a member, look at the corresponding assignment folder, and then open the last posting of student A. Finding student A's most recent posting would be done in a few seconds. Since the assessment of the online assignments was strictly based on the presence of the number of postings, what the instructor needed was to count the number of messages each student had under each class assignment folder. The instructor's

experiences prove the necessity of a systemic process for placing postings in order to save time in locating and assessing students' online activities. Organizing the discussion board according to first groups, next assignments and finally according to individuals as done in the research course promise a more effective, less confusing and less stressful online discussion forum.

Table 2. The number and the frequency of discussion board use.

	Math5360(N=22)	Math3323(N=45)
Total number *	**433**	**218**
Frequency (*/N)	**19.7**	**4.8**

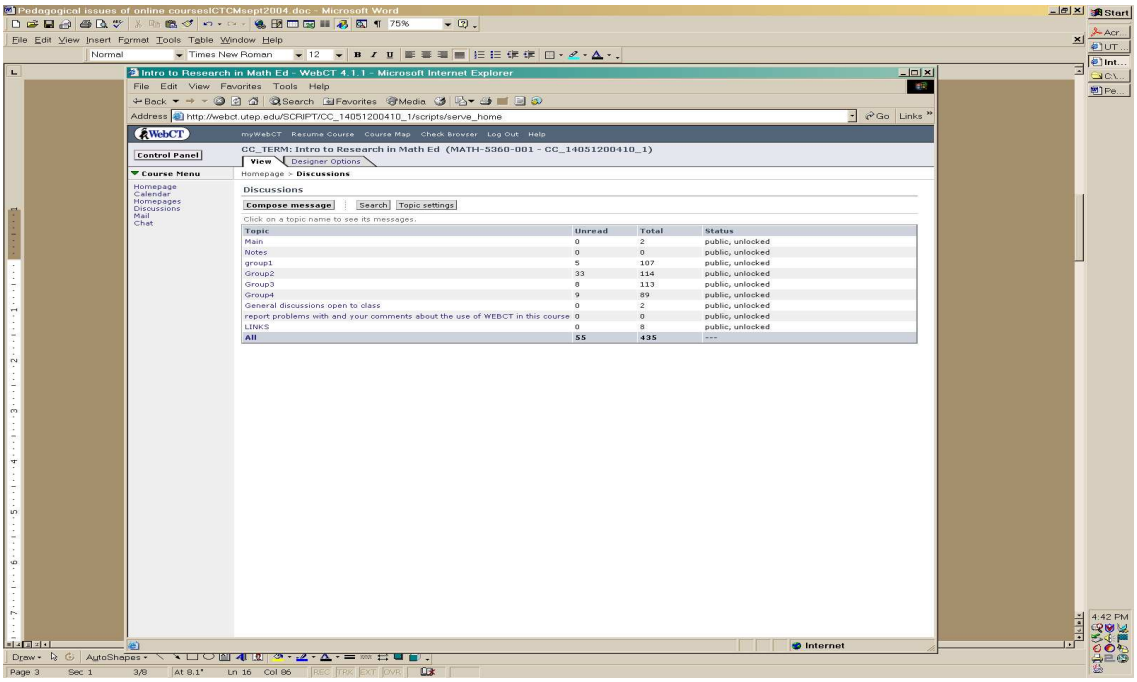

Figure 1. A student customized design of a Discussion Board according to group assignments.

In the matrix algebra course, the Discussion Tool was primarily used to post responses to questions on a set of web-based experimental activities. These questions required students to justify answers and explain reasoning for the observations and conjectures resulting from the online experiments. Matrix Algebra students were recommended (not required) to reflect on their classmate's postings. Very few actually have taken the time to read them. Again, the number of postings the instructor had to read for assessment was overwhelming.

There were 45 students enrolled in the course, and they were to post individual responses. This became a challenge for the instructor to read before each class meeting in order to adjust the future instructions accordingly, and to address potential misconceptions

majority may have displayed on their postings. Students were also to place reflections on their readings, assignments and activities. This was a recommendation but not a requirement hence they were not assessed. Consequently, very few students posted reflections. Even though students were put in groups of tree to four, and strongly recommended to use the discussion board to communicate with group members, there was a very few who did so. One should note that the matrix group consisted primarily of engineering students, and some had a full time jobs as well as a heavy course loads, which left them no time for in-person meetings with their group members. The discussion board was the best option for them to carry on conversation yet they did not take advantage of this. This might be attributed to the fact that their online group activities and reflections were not assessed. Contrary to the lack of online reflection messages and the online group conversations, since the postings of the responses on the assignments were required and assessed regularly, it had the highest number of postings. Approximately 90% of the number reported on table 2 for math3323 is for the messages on the required assignments.

Conclusion

It requires an informed instructor to take into account the pedagogical and organizational issues that may occur due to the nature of the technology-based learning environments. Because of the lack of student-instructor face-to-face interaction in these environments, instructors may never become informed of the potential problems during the semester unless a continuous feedback mechanism is embedded into the process. They need to become aware of the pedagogical and organizational issues in advance to be able to make necessary adjustments whenever needed. After the online learning environments are designed, and the course requirements are set, instructors make very little contact with the learners. Therefore, during the semester, they may not get opportunities informing them of the amount of time students spent on line; the nature of the students' involvement and participation in online activities; and how well students follow online instructions as well as find and use appropriate information and tools.

It is praiseworthy that the instructors of mathematics have been increasingly using technology to provide social constructivist learning, though it is not enough to just use technology. For effective learning, one also needs to think about the feasibility and the acceptance issues that occur with the technology use. The following recommendations are made according to the author's experiences with the online learning environments for the instructors of mathematics to increase learner participation in their online courses:

- Organization and customization of information, course material and communication tools according to learners' and instructors' need (Mabrouk, 2002).
- Making the use of communication tools integral to the course requirements (Marinas, 2002).
- Assessment of activities and participation: The instructors need to show learners that their online activities and participation are valued and assessed regularly (Marinas, 2002).
- Taking into account the time needed for assessment. For large-size classes, group-based online assignments can help reduce the time spent for assessment.

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