Online Mathematics courses: A New Paradigm in teaching and learning

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Abstract
Online education influences the educational process and the individual learners in different ways. As more and more colleges and universities embark on offering courses to geographically scattered populations of students, it is best to know how to create learning environments that engage students in interacting with one another while learning and applying the course material. It is certain that by re-organizing and adapting the ways materials are presented to students, instructors can create an environment in which knowledge retention is significantly increased; needless to say that such situation require the cooperation of students as well. One of the best methods to do so is to implement *active learning.* This means that instead of simply receiving information, students are receiving, participating and doing. It involves putting students in situations which compel them to read, think deeply, and write. Transition to an online course that focuses on active learning requires attention to planning and organization. An interactive online learning environment requires an integrated design rather than a collection of disconnected and unrelated learning activities.

Introduction
The World Wide Web provides a useful tool for learning mathematics when used as part of an overall active learning and teaching strategy. The computer communications revolution of the 21st century brought a "paradigm shift in attitude towards online education," and "our new understanding of the very nature of learning has affected the definition, design, and delivery of education" (Harasim, 2000, p. 42). Van Weert (1994) argued that computers would also force mathematics education to change its focus, its organization, and its use of technology. He continued, "The focus will change from teaching to learning, its organization will change from rigid class based learning to flexible team based learning, technology will be integrated into the learning process and will support both this new organization of learning and the learning tasks of the individual student" (p. 621). Research on cognitive learning suggests that although students learn in different ways, yet all meaningful learning that emphasizes understanding and acquisition of knowledge requires active participation on the part of the learner (shuell, 1986). Online education has addressed tough questions about the value and quality of learning and teaching. However, we need to address how educator's new knowledge about online teaching and learning will affect their design and delivery of online mathematics courses.
Today, evidence suggests that much of the rush for developing online courses were undertaken in haste, without special attention to the learning of the students. It seems that many educators have approached the development of online courses as a reaction to the competition for attracting more students to their colleges and universities. Now we are witnessing the consequences of lack of planning for teaching of such courses. This repercussion is evident in students' protest over their difficulty with the grasp of an online curriculum of a course, and their complaint that they do not have access to an instructor who understands their problems. Is online education in jeopardy? No, it is indeed time for educators to reevaluate their approach to the design and delivery of an online course and focus on active learning. This transition requires attention to style and mode of delivery, frequency of contact and meeting place, technology, assessment, and teachers' role.

Creating an Active Learning Environment

Learning mathematics as Goldsmith and Shifter (1997) put it should become process of "conjecturing, discussing, testing, playing with, revising, and extending ideas about mathematical objects" (p.33). Learning is not just a process of reception, rather a constructive pathway to collection of knowledge, influenced greatly by what is already known (King, 1992). More and more there is a trend in revising the conventional view of mathematics learning as the mastery of a fixed set of facts and procedures to processes that encourage investigations, sense making and communication in a classroom. Bringing about these changes in mathematics instruction requires that teachers possess beliefs about mathematics, teaching, and learning that is significantly different from school mathematics traditions (Battista, 1994). The success of online mathematics courses depend on the teachers making a significant shift in their beliefs and practices that are deeply tied to school mathematics traditions. Teachers should promote activeness in learning by encouraging self direction, problem solving, goal setting, reasoning, and reflection.

In this new global communication environment, we must go beyond the known and conventional in order that we provide simulated cognitive pathways to learning material.

Active learning in an online mathematics course refers to techniques where students do more than simply reading a lecture and preparing for the tests. Students are engaged in discovering, processing, and applying information. Active learning is derived from two basic assumptions that, (1) learning is by nature an active undertaking and (2) different people learn in different ways (Meyers and Jones, 1993). Research also shows greater learning when students engage in active learning. It is important to remember, however, that online course material does have its place and that teachers should not do active learning without attention to content or objectives. Active learning is not a new idea. It goes back at least as far as Socrates and yet, if one looks closely into many classrooms, it becomes clear that learning is in nature an active process. It involves putting students in situations which require them to read, think deeply, discuss, listen, write and be engaged in solving problems. Most important, to be actively involved in their learning, students must take on higher-order thinking tasks such as analysis, synthesis, and evaluation. Active learning strategies are instructional activities that involve students in doing things and thinking about what they are doing.

Learning is an active search for meaning by the learner. In this process the learner is constructing knowledge rather than passively receiving it, shaping as well as being shaped by experiences. Active participation by the learner is vital for meaningful learning.

It is evident that one can distinguish between good and poor learners on the basis of self initiative and activeness with which they pursue learning (Chi & Bassok, 1989). In an online environment an active learner behaves differently than one who is in a face to face classroom. In an online mathematics course we can assess active learning through discussion in the online environment. Here the student reads what other students have posted, post responses that directly address the issue being discussed and posts statements that are in depth. On the other hand, a student who is less active learner will be less likely inclined to read others' posts, less likely to respond directly, and less likely to offer in depth analyses and thoughts on the issues discussed. The single greatest barrier to teaching in an active learning environment is the fact that teachers' efforts to use active learning involve risk, the risks that students will not participate, use higher-order thinking, or learn sufficient content. Some teachers feel they will experience a loss of control, or will be criticized for teaching in unconventional ways. Certain obstacles that are associated with the use of active learning include possible increase in preparation time, the potential difficulty of using active learning in an online mathematics course, and a lack of needed

materials, equipment, or resources. Each obstacle or barrier and type of risk, however, can be successfully overcome through careful planning.

Using the Web to promote Active Learning

Contrary to the conventional wisdom active learning strategies can be transferred to online mathematics instruction. In traditional settings large classes make it difficult to engage all students in meaningful discussion (Brown, 2002). In online environment, however, instructional software makes it easy for teachers to overcome class size by allowing students to participate in small online discussion groups (Hamann & Wilson, 2003). Angeli, Bonk and Hara (1998) have found that online discussions are potentially "lengthy, cognitively deep, and indicative of a student oriented environment," clearly linked to active learning process (Bender, 2003). Transition to an online setting that encourages active learning requires special attention to the following:

Style and Mode of delivery - Text is the learning medium in an online environment, so the challenge is to initiate active learning as opposed to passive reading. As mentioned by Ausubel, "any text used for teaching-learning purposes must be developed in a way to facilitate learning not only by providing information but also by helping the learner to relate newly acquired knowledge to what is already known" (quoted in Holmberg, 1995, p. 88). Active learning has as its main principle the teaching of "thinking" – both creative and critical thinking skills. Because active learning is an approach and not a method, it can be designed to fit any curriculum or course; however, the teaching of thinking remains at its center.

Frequency of Contact – In an active learning environment teachers' frequency of contact with the students determine learners' degree of participation in the course. Frequent and prompt responses from the teacher ensure that students' participation in the course remains active and meaningful. Online students expect to be in touch with the teacher and other students 24 hours a day, and 7 days a week. Some institutions have developed policies for instructors to reply to all online students email within a set time (Waterhouse & Rogers, 2004), whereas anecdotal evidences show that many online teachers have an "obsession when it comes to their online courses-a mixture of curiosity and a sense that if they don't keep logging on, they might fall hopelessly behind" (Young, 2002, p. 38).

Communication – The World Wide Web provides new opportunities for active learning. Becker (1997) reported that "the need for active student involvement with classmates in the learning process" is one of the important elements in increasing students' performance and interest in the subject. The Web is an accepted tool for increasing student-student as well as student-teacher interaction through the use of discussion forums or online chat. Discussion forums can be thought of as you would "in class" participation. These forums should be a rich source of learning in order to encourage critical thinking and be an integral part of a course. Unless the online participation of students is assessed, on average one third of students will seldom participate in online activities (Curtin, 2002). Discussion forums can be used to engage students in collaborative problem-solving, and create an online community as students elaborate on discussions and continue to deal with unsolved issues.

Online students need to receive frequent feedback and cannot seem to get enough. Feedback (or the lack thereof) is the most frequently mentioned concern of online students. To quote from online student evaluations, faculty who provide meaningful and frequent feedback are viewed as "excellent", "very good", "concerned", and caring" while those who provide superficial or infrequent feedback are viewed as "not very good", "poor", "unconcerned", and "arrogant." Learning is facilitated when students get feedback about their thinking, whether that feedback is from the teacher or a peer.

Technology - Often educators begin their development of an online course by selecting the technology tools first, then allowing the tools to determine the pedagogy. This technique leads to courses that are governed by technology instead of using technology to further the students' learning environment. Selection of technology should reflect ones specific educational environment, communication, and technical capabilities needed for the delivery of the curriculum. As per Hillman, Willis, and Gunawardena (1994) there should exist an interaction between the learner and the technology that helps deliver the curriculum if students are to be engaged in active learning and spend less time learning how to interact with the technology. Using technology in delivery of mathematics courses is a natural connection. Instructors need to understand the big ideas in mathematics and know how to represent mathematics in a comprehensible and connected manner (Ma, 1999). Instructors should be careful not to use technology along with the curriculum just for its own sake. Technologies should be used to foster exploration, easy representation, as well as simple modification of concepts and mathematical practices.

Assessment - The purpose of the assessment could either be formative or summative. Formative assessment could be looked at as a way to help form and develop student learning, and summative assessment as a way to sum up what has already been learned. In most distance settings there are usually both a formative and summative component in assessment (Morgan & O'Reilly, 1999). When the two components are well integrated and developed, it is then possible that deep and relevant learning can take place. If assessment is structured in such a way that one assignment is built upon the next, with formative feedback, it could be an important way to enhance students' learning.

Teacher's role - In an online environment the teacher is a coach or even a collaborator in the knowledge construction process (Reeves & Reeves, 1997). In this environment, the instructor does not remove himself from the educational process. As pointed out by Portela (1999), the teacher's role is shifted from the deliverer of instruction to being the creator of learning experiences for the students. The pedagogical knowledge of an instructor is also an essential factor in the curriculum design of an online mathematics course that focuses on active learning. The instructor with this knowledge base is able to come up with examples and rich applications that enable students to see the usefulness of mathematics, its link to other disciplines, and the connection between ideas in mathematics. It is important that instructors possess this knowledge, as it will enable them to be aware of the challenges that students possibly encounter in learning mathematics.

Conclusion

The online environment provides new opportunities for teaching and learning mathematics. It provides students new ways to communicate and learn without regard to time or geography constraints. However, the challenge will be learning how to combine the World Wide Web with the active learning and teaching strategies to make mathematics more relevant to students and in the process create an improved learning. Traditional instruction methods do not adapt to the online active learning environment. Online teachers should provide interactive learning environments in order to maximize learning. In such environment the accountability for learning needs to shift from teachers to learners. As more students take online courses it is vital that educators be able to move students from access to information to educational experiences that empower knowledge construction by unsophisticated mathematics learners and help them make sense of massive information.

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