WHERE ARE WE NOW?: A REPORT ON THE EFFECTIVENESS OF USING AN ONLINE LEARNING SYSTEM TO ENHANCE A DEVELOPMENTAL MATHEMATICS COURSE

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Introduction

A state of crisis exists in developmental education in the state of Georgia. According to

data from state higher education institutions, out of more than 37,000 students who entered the system in Fall 2004, 6,627 were required to take developmental mathematics. Of those only 38.9% exited within two semesters. Forty-five percent had not exited by Fall 2006 and were not enrolled. In Fall 2007, a redesign of developmental mathematics at the authors' institution resulted in an innovative self-paced course in which technology is used to individualize the mathematical learning of students. The course has resulted in a 49% exit rate with a mean time in the course of 1.6 semesters while raising the college algebra grades of developmental students compared with similar students in the University System of Georgia. This paper presents the model for the course and quantitative data showing its effectiveness in retention and performance in subsequent mathematics courses.

The Issues

Students who enter college without adequate preparation are often placed in courses designed to compensate for their inadequate preparation and prepare them for college-level mathematics courses. These compensatory courses usually make use of the same lecture-based techniques that have failed these students in the past. These courses also do very little to address several known issues that make teaching and learning more difficult. These issues are that students have different math expertise, they have different learning rates, and that they are ill prepared for college-level work.

Lecture-based approaches to teaching mathematics assume that all students are the same and encourage students to be consumers of mathematics rather than producers of mathematics. The traditional approach of a mathematics professor standing at the front of

a class lecturing to a class of students treats the students as identical raw material. Each student is assumed to enter the class with the same knowledge and to learn at the same pace. Some professors make concessions to reality by giving first-day assessments to determine the overall mathematical preparation of the class. The professor begins teaching material appropriate for that level of preparation. Professors can also pace the class at an appropriate level by obtaining periodic feedback about students' understanding as the class progresses. Some ways of obtaining feedback include quizzes, class work, taking up homework, and student response devices (clickers).

"The essence of learning math is doing math, rather than passively listening." (Thiel, Peterman, and Brown, 2008) Lecture-based mathematics classes encourage students to be consumers of mathematics rather than producers of mathematics. Students watch mathematics professors talk about mathematical definitions and concepts and then work example problems. But mathematics is not a spectator sport. Ideally, students abstract from the examples the mathematical concepts and are able to apply those concepts in solving problems on their own. The majority of these student problems are given as homework and students must try to figure out on their own how to apply the concept. For students who are already inadequately prepared mathematically, such abstractions and applications prove problematic.

A number of different approaches have been proposed to move away from a lecture-based approach. The University of Missouri-St. Louis has implemented a redesign of their college algebra course in which a three-day per week lecture format was replaced by a

hybrid format with one lecture and two computer lab sessions (Thiel, Peterman, and Brown, 2008). Students did homework during lab sessions using a program that gave them immediate feedback. Students learned how to work the practice problems with support from the software. They received immediate feedback and could rework problems of the same type they had answered incorrectly. As a result, the college algebra course has seen a rise in successful completion of the course from 55 percent to 75 percent without reducing the standards of the curriculum.

Designed to Address the Issues

The Pre-College Algebra course at Georgia Gwinnett College was designed to address some of the issues in addition to some ideas about course redesign from the National Center for Academic Transformation (NCAT) and the American Mathematical Association of Two-Year Colleges (AMATYC). This innovative design includes self-pacing, early exiting which allows the students who just need a review to finish the course early, just-in-time teaching which helps students with what they need when they need it, and is web-based which gives the students flexibility to work on the course at home or at school.

The self-paced nature of the course allows students one, two, or three semesters to learn the content in traditional compensatory courses. The content includes topics from Arithmetic, Beginning Algebra, and Intermediate Algebra. So instead of students being placed into specific levels (which can often include topics the student has mastered and omit topics the student has not mastered), the students are placed in one course. In this

classroom, each student can begin with what they know. In addition, this course eliminates the need for distinct courses by placing students at different levels in the same course.

Of course there are challenges that come with a classroom filled with students with different preparedness levels. Most of the challenges are for the instructor. The Instructor must be flexible and give various mini-lectures to suit a particular student's learning style. This just-in-time teaching allows each student to get the customized teaching they need, exactly when they need it. The course instructor circulates through the classroom answering individual questions. The instructor may also give a mini-lecture for groups of students working on the same topic.

Another key aspect of the course design is that it is mastery-based. Initially, students are given an assessment to determine what they know. Based on the assessment, topics are available for the student to study which build upon the topics that are mastered. More difficult topics covered in the course are locked until the student has mastered prerequisite topics. Once the prerequisite topics are mastered new topics are opened up. The students are also encouraged to revisit content that they have already mastered. Frequent assessment is also built into this component to ensure that students retain the material that they are learning. Assessments can be triggered automatically or by the instructor, and they can be designed to include topics previously mastered by the student. Again, this is included to promote retention of the course content.

Students who score well on the initial assessment need to be in the class for only a few weeks reviewing material before taking the required exam to exit the course. All students have to complete 90% of the available topics in order to qualify to take the required exit exam. For some students, this takes one semester; others take longer.

Teaching mathematics by presenting students with problems for them to solve and providing them with instant feedback on the correctness of their answers allows students to actively learn the mathematics. Rather than being passive absorbers of a traditional lecture, the students are actively engaged with doing mathematics. However, expecting students to read an explanation and understand all of the nuances and features of the explanation may be too great. That is another reason to have a classroom instructor engaging the students in order to make sure that they understand the concepts behind the solution as well as the actual solution.

Finally, in order to help students make the transition between high school and college, the teaching of study skills is incorporated into the course. These are designed to help students learn how to manage time effectively, how to keep a good notebook for their mathematics classes, and how to study effectively. Topics such as learning styles and active listening and notetaking are also discussed. Some faculty also incorporate activities or talks designed to inform students about the college and processes such as financial aid or class registration.

How is it working?

The authors' institution is a four-year college with a very diverse student body. As of 2009, the population was roughly 52.4% male, 47.6% female with 69.6% of the students enrolled full-time. The average student age is 23.7 years with about 23.8% of the students being of non-traditional age. The school draws from one of the most diverse counties in the nation and the student body is mostly Asian, African-American, and Caucasian.

From Fall 2007, when the course was first implemented, through Summer 2009, 480 students have been enrolled in pre-college Algebra. Of these, 62% qualified to test to exit program and 48% of the 480 students successfully passed the test. This compares favorably with the 49.6% for the University System, indicating that the design of pre-college Algebra is not preventing students from successfully completing the developmental mathematics program any more than a traditional lecture-based design does.

One significant measure of the success of a developmental mathematics course is the performance of students in subsequent courses. Data gathered over the four years in which pre-college Algebra has been taught, Fall 2007 through Summer 2010, indicates that the course is performing very well based on student performance in college algebra. Figure 1 (below) shows the grade distributions in College Algebra who took Pre-College Algebra.

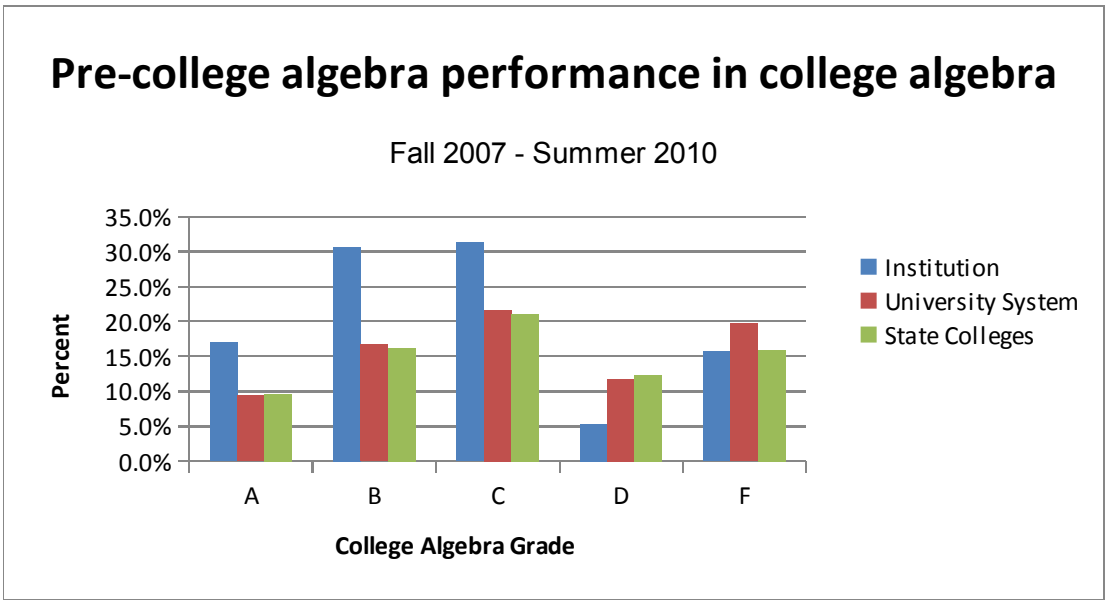

Figure 1 : Comparison of pre-college Algebra students in College Algebra

Because the number of students who enrolled in Pre-college Algebra and went on to College Algebra is low, the data for Pre-college Algebra was compiled over the lifetime of the course, Fall 2007 through Summer 2010. During that time, 300 students who had previously enrolled in pre-college Algebra went on to take College Algebra compared with 6623 in the University System overall and 1766 in the state colleges alone.

The data on the effectiveness of Pre-college Algebra is quite positive. Students earned A's and B's at almost twice the rate of the USG overall. The DWF rate for Pre-college Algebra students in College Algebra is 30.9% which compares favorably with the corresponding DWF rate for the USG of 51.4% and four-year state colleges alone of 51.9%. The data indicates that students have benefited greatly from taking Pre-college Algebra.

Changes on the horizon

In Fall 2010, it became necessary to increase class sizes to cope with unexpectedly large enrollments. The class sizes increased from 15 to 28. However, tutors already employed by the college were added to the classrooms so that each class had an instructor and tutor. This made the ratio of students to math teachers 14 to 1. Current anecdotal evidence indicates that the addition of a tutor has been effective due to students being able to have a more varied interaction with the teachers. If a student doesn't understand one teacher's explanation, the student may understand the other teacher's.

Assessment of the performance of the students, designing new ways of engaging students, and helping students learn mathematics will continue. We also continue to design new ways of training instructors and engaging them in the innovative course format.

Bibliography

American Mathematical Association of Two-Year Colleges. (2005). “Beyond Crossroads: Implementing Mathematics Standards in Two Year Colleges.” AMATYC, Memphis, TN.

National Center for Academic Transformation. (2010). “Roadmap to Redesign. “Retrieved from http://www.thencat.org/R2R.htm.

Thiel, T., S. Peterman, et al. (2008). “Addressing the crisis in college mathematics: Designing courses for student success.” Change: The Magazine for Higher Learning

(July/ August 2008): 44-49.

University System of Georgia (2009).

http://www.usg.edu/research/students/ls/lsfeedback/PDFs/2006/LSstateColl-fy06.pdf

University System of Georgia. Academic Data Mart and/ or Student Information

Reporting System. (2010). http://www.usg.edu/research/students/ls/ls2.phtml#