A ROAD TO REDESIGN IN COLLEGE ALGEBRA AND PRECALCULUS

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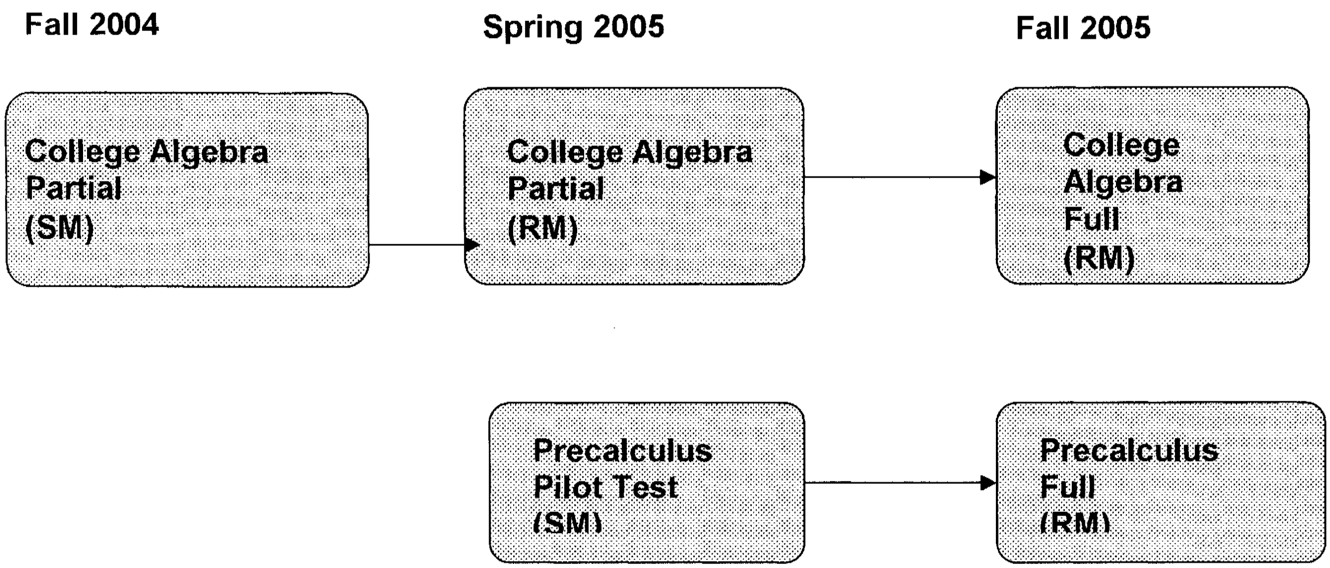
Introduction

While the traditional lecture dominates college and university classrooms, research shows that students need to do more than just listen. Much has been written about the need for active learning in postsecondary classrooms (Sutherland and ***Bonwell*** 1996; ***Bonwell*** and Eison 1991; Chickering and Gamson 1991; Johnson, Johnson, and Smith, 1991; McKeachie, Pintrich, Lin, and Smith 1987). A student who is *actively* involved in the learning process (rather than sitting in a room *passively* listening while an instructor lectures) improves that student's learning and retention of that knowledge. Including instructional technology in this paradigm has led to even more success – improving student learning as well as reducing the cost to the student (determined by the number of attempts a student makes in a class before being successful) and the institution (http://www.center.rpi.edu/PewGrant/Proj_Success.html). In order to implement such a shift in the learning paradigm (from 'tell me' to 'involve me') in our large enrollment mathematics classes, a redesign of how we teach our courses had to be undertaken.

During the fall of 2004, the department of Mathematics and Statistics initiated a redesign project for College Algebra, an introductory course enrolling over 1500 students each year in 41 sections. The College Algebra course was redesigned based on the mathematics replacement model (Twigg, 2003). This model replaces traditional lectures with a variety of learning resources such as software packages that encourage active student learning, prompt ongoing assessment, and provide individualized assistance. Instruction may be improved via departmental training for instructors and graduate research assistants (GRAs). The faculty and GRAs receive training in the tutorial software.

During the spring of 2005, a partial redesign was initiated in the Precalculus course which is also an introductory, high-enrollment course in the department. The fall of 2005 brought full redesign to all sections of College Algebra and Precalculus.

Redesign Implementation



SM- Supplemental Model RM – Replacement Model

Our focus in this project was on College Algebra (M.ATH 1111) and Precalculus (MATH 1113) in the full implementation phase. There are significant failure rates in College Algebra and Precalculus. Redesigning these courses has allowed us to take advantage of computer technology available on campus and to provide students with options of choosing their best learning conditions and with opportunities to enhance their learning using resources beyond boundaries of time and space. Our previous goals were to significantly reduce the DWF rate in College Algebra and Precalculus and to better prepare students for subsequent courses in mathematics. The course redesign appears to be successful, but we now have the charge of thoroughly evaluating the redesign for several effects. We are currently collecting data in order to do the following:

- Investigate the variables that affect student learning in the redesigned courses
- Research the students' perceptions of their own preparedness for subsequent mathematics courses;

Methodology

The research team designed and tested instruments to determine how the model affects how students learn. The team will also conduct interviews in an attempt to discern the students' opinions of their own learning. We will compare the students' performance on tasks in the classroom and in The MILE.

To answer the question "Did they really learn?" we will employ the following assessment techniques suggested by Peter Ewell, Senior Associate at the National Center for Higher Education Management Systems (Twigg, 2003):

- *Common Examinations:* This refers to a final examination with selected common items that is administered to students to allow us to analyze instructor and student effects.

- *Student Work Samples:* We will select a few examples of work that students complete as a part of the course. Once a reasonable sample (n=20 or so) from each class is assembled, the pieces can be cross-scored by a reading team using a scoring guide to look at things like communications ability, mastery of particular areas of knowledge, and so on.

- *Behavioral Tracking:* This approach relies on following students who were enrolled in parallel sections (innovative and traditional) through student records to see what happened to them later. Several dimensions of behavior are especially useful to look at here, including
    - Course completion rates;
    - Program completion/graduation;
    - Grade performance in subsequent courses for which College Algebra and Precalculus are prerequisites.

- *Attitudinal Shifts:* We will rely on student opinions about changes in their own levels of confidence about the material. We will attempt to detect any decreases in math anxiety as result of the self-paced, problem-oriented course delivery using technology.

The team will conduct interviews of students who have completed an entire cycle through the redesigned College Algebra and Precalculus courses and are now in Calculus. The purpose of these interviews will be to investigate how these students perceive how the redesigned courses prepared them for Calculus. We will also collect data on the students' performance in Calculus. We will collect data on the DWF rates and compare them to the past years in these courses. During our pilot study, there were still traditional classes (not redesigned) that we could assign as the control groups. In the current, full-implementation phase, there are no control groups. The nature of the research had to change so that we could analyze the results of the redesign and track the students into their subsequent mathematics course.

Results and conclusions

In the spring, common questions were given to all College Algebra students. These questions were multiple choice and so were marked simply right or wrong. All sections of the redesigned sections used common assessment elements throughout the term including the formula for determining the final grade in the course. The Precalculus assessment items were very task-oriented in an attempt to prepare them for Calculus. Student responses to these questions were copied and graded using a common rubric.

A chi-square test for difference of distribution was performed on the grade distribution of the students in the redesigned sections with the historical distribution (spring 2000-2004). Also, a chi-square test for difference of distribution was performed on the grad distribution of the students in the redesigned sections versus the traditional sections in the spring semester. For College Algebra, a difference in performance between the two groups was not found to be statistically significantly at a confidence level of $p < 0.003$ for either the historical or the traditional distribution. For Precalculus, no significant difference between the two groups was found ($p < 0.003$) for the historical distribution, but there was a significant difference between the two groups when compared to the traditional course in the same semester as the redesign. No significant difference in the race or gender of the population of students was found for either College Algebra or Precalculus.

	chi-square	p-value
College Algebra: Traditional (2000-2004) vs. Redesign 2005	20.18683	0.002565
College Algebra: Traditional 2005 vs. Redesign 2005	22.89597	0.000832
Precalculus Traditional (2000-2004) vs. Redesign 2005	20.01247	0.002755
Precalculus Traditional (2005) vs. Redesign 2005	8.420367	0.2088895

The interview process is ongoing and the research is far from completion. One preliminary conclusion that can be drawn, however, is that instructor training is the most important factor in the success of the redesigned courses. It is essential that instructors are comfortable with the computer interface and the change in the classroom format.

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