Technology for Pre-service Teachers

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Abstract

Math Concepts I and II are the three-credit courses required of pre-service elementary and middle school teachers at a diverse, mid-size, southwestern, urban, open-admissions university. This paper will discuss the course use of established technology including a) a department-owned set of calculators, b) the classroom presentation computer, and c) the overhead projector. Further, the paper will describe course results before and after new technology was introduced. To increase the time and effort students spend on homework, study for tests, and work on the course in general, new technology, namely the use of the publisher's online materials has been incorporated into the course.

Milieu

Pre-service elementary and middle school teachers' degree requirements at a diverse, mid-sized, southwestern, urban, open-admissions university, called Downtown University for the purposes of this paper, include two mathematics courses beyond the college algebra level. Math Concepts I and II are the three-credit junior courses currently offered every semester for pre-service teachers. The department syllabus specifies the required textbook, the sections of material recommended for each course, and states that there should be three or four tests. The syllabus also suggests a time schedule for each chapter and encourages the use of the publisher's online materials.

The department syllabus' Goals/Objectives for Math Concepts I include "Students should be able to perform and explain arithmetic with whole numbers, fractions, and decimals in a variety of modes, understand place value and various number bases, be familiar with diverse historical number systems and use problem-solving skills for word problems. There will be an emphasis on word problems, calculators, and NCTM Standards." (Downtown University, 2007a). The department syllabus' Goals/Objectives for Math Concepts II include "Students should be able to apply elementary principles of counting, probability and statistics - including multi-stage probability, expected values and graphs; understand relationships among lines, planes, angles, polygons; calculate measures up to three dimensions; convert volume, capacity, mass, and temperature in both English and metric systems. There will be an emphasis on word problems, calculators, and NCTM Standards" (Downtown University, 2007b).

Problem

In order to increase the time and effort pre-service teachers spend on homework, studying for tests, and working on their mathematics course in general, the required use of the publisher's online homework materials was incorporated into my classes starting with the Fall 2006 semester. The students' increase in time and effort was anticipated to lead to an increase in knowledge which in turn would lead to an increase in the mathematical abilities and confidence of the pre-service teachers. It was expected that any improvement in these areas would be evidenced in higher grades and fewer students dropping the course. The need for improved results in teacher education programs is exacerbated by the general poor achievement of students, even in fundamentals, in schools across the United States and is such common knowledge that discussions about it show up in the media (Shannon, 2005).

Various demands coming from business, education, and the mathematical community stress the need in modern society for fluency in numeracy and quantitative reasoning (Farrell, 2002; Lutzer, C., 2005; NCTM, 2000; Steen, 2002, 2004). American employers are finding themselves in the position of having to train new hires who frequently arrive with an inadequate education

preparation for entry level positions. Workers are finding that mathematics knowledge can correlate with economic success. The ability to calculate, compare, and interpret is needed by all workers, consumers, and voters in our highly technological modern society. An important mandate for the public education system is that all students become increasingly numerically literate. Basic to an individual's mathematics development are their teachers' own competencies as well as positive attitudes towards mathematics knowledge. Increasingly, researchers (Betts, Zau, & Rice, 2003; Carter, 2005; Gehrke, 2005; Henke, Peter, Li, & Geis, 2005) are reporting on the importance of content and pedagogical knowledge for effective teaching.

Reflection on why learning mathematics is difficult. The majority, and surprising, response to a research survey of mostly African-American or Hispanic high school dropouts to the question of why they quit school was "Math" (Viadero, 2005). Some of the reasons given for their lack of success with mathematics included the fact that they were pushed through courses when they lacked mastery and understanding of the material, they felt bored, they had teachers they did not consider to be smart, and they had textbooks of poor quality. It was further reported that "math could be hardest on minority students, many of whom attend schools with fewer resources, less experienced teachers, and more teachers teaching subjects for which they were not trained" (Viadero, p. 2).

Reflection on why learning mathematics is different. Mathematics is a very special language that must be learned to be practiced and practiced to be learned (Seeley, 2004). It must be learned well before it can be taught effectively. Parallel to this, if a teacher has strong mathematics content knowledge but lacks pedagogical knowledge, that teacher will not be effective in sharing their knowledge story with their students (Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Santos & Santos, 2005). When pre-service teachers come as students into a mathematics class with lived stories and told stories of anxiety, lack of study skills, and a weak mathematics background, there are many things besides the mathematics that Math Concepts teachers have to teach as well as overcome. While not all pre-service teachers will have had a strong mathematics background, their college mathematics courses must ensure they are mathematically competent and have a positive mathematical attitude. Pre-service teachers need to be nurtured by many positive mathematics experiences to develop into good mathematics teachers.

Incorporation of Technology

A few years ago I incorporated technology into the course by using a department purchased class set of TI 73s. These calculators are available to students on the days when the set is brought to class and for all tests. Working with a TI 73 gives the pre-service teachers practice with the type of calculator they are expected to use in their teaching. After our discussions and class work with the calculators, I have noticed more and more students making wise choices about when to use mental mathematics, paper-and-pencil calculations, or a calculator (NCTM, 2000). In a way this learning is forced on them since I specifically do not bring the calculators on some class days.

For several years, I have been submitting requests for room assignments that include a classroom presentation computer. I utilize the computer from the first day of classes when I show how to find the syllabus for the course web page. It is useful in pulling up research articles for class discussion and whenever I want online access to materials prepared for class. Computer images are much clearer than those from transparencies on an overhead projector. I still use an overhead projector to demonstrate model lessons on such topics as two-color counters, different base blocks, and plane figures.

With the arrival of a new edition of the textbook, recent discussions among faculty involved with the pre-service teacher courses led to revision of the syllabi. The incorporation of the publisher's online materials is now suggested. The new packages for students include not only a textbook and an activities book but also an online access code. In this way all students can supplement

their work with online homework practice. To aid their study of mathematics, the online materials include links to power point lectures, a multimedia library, and a self study plan, as well as links to check answers, see similar examples worked out, read step-by-step directions (after which the numbers in the problem are regenerated), watch videos on selected topics, find the textbook pages, e-mail the instructor, access help from mathematics teachers, and technical assistance.

Following the department syllabi guidelines, I evaluate my pre-service teachers based on three tests, a time-and-effort grade, and a final exam. The time-and-effort grade consists of items such as homework, attendance, group work, and class activities. For fall 2006, as a teacher researcher (Rearick & Feldman, 1999), I designed my classes to incorporate the use of online homework materials instead of my former method of assigning, collecting, and grading homework from the textbook problems in each section. I now select homework problems from the book's online question bank. One chapter at a time is assigned and made available to the students so that revisions in the next chapters' assignments can be incorporated following formative evaluations. Students may do their homework using any computer that has online access. These are not the only courses on campus to use this publisher's materials and all the computer labs are routinely updated with necessary software. For students who prefer to do their homework off campus, there are directions for setting up access as well as receiving technical support. Some students work ahead of the class pace in a chapter to see what they already know and some of these receive quick 100s. Some students do the homework after the material is discussed in class as recommended by the syllabus. Some students catch up before exams. A very positive feature is that the computer gives instant feedback, far more than a simple "right" or "wrong," while the students are working through the homework problems. In order to receive credit they now not only have to attempt the assignment and show they are working but they also have to calculate the correct answers to the questions. The computer continuously records, in the online grade book, time spent on tasks in addition to the point value I set up for it to assign to each correct problem. Previously, I would visually scan the homework papers and write a few comments so that most of the items were graded quantitatively and only occasionally did I have the time to use a qualitative rubric. Now the computer recorded homework grade is a qualitative, as well as quantitative, evaluation of the student's work. Furthermore, this technology acts as a helpful and impartial judge while developing the students' mathematical knowledge.

While each student has a different computer generated question, if there are any difficulties, problems are discussed in the next class. I have found that when students now ask questions on the homework they are often looking for alternative methods or techniques for solving the problems. The computer program currently shows a unique way to solve each problem. Much less class time is now spent going over homework since the computer essentially provides private tutoring during their homework practice.

The online grade book shows that some students complete the minimum assigned while others explore additional features such as practice tests. I welcome the saving of my time that would otherwise be spent on grading homework and doing averages. The students also seem to appreciate many of the features, such as the ease of availability of the course materials and their grades, afforded by the computer's administration.

Results

The student response to incorporating online homework assignments has been positive in that most do the online homework assigned. My course results from incorporating online homework showed slightly higher course grades in comparison to my classes who worked with the previous textbook edition but not the online homework. Prior to the new technology requirements, students who passed Math Concepts I or II (n=138) averaged about 90.1 in their time-and-effort

grade while averaging 80.7 in the course. Starting with the fall 2006 semester, students who passed these courses (n=96) averaged 90.4 in the time-and-effort grades and 81.6 in the course. Students come into mathematics classes with a preconceived expectation of the grade they want to earn. Many have asked me if they need to have all 100s to receive a homework grade or if they can stop with what they already have. When their desired grade is assured, they do not seem willing to put in more time and effort to achieve a better grade. Compare Figures 1 and 2 for details on the upward movement in the grades. Prior to the new technology requirements, 19% (33/171)

Figure 1. Grades Prior to New Technology Requirements

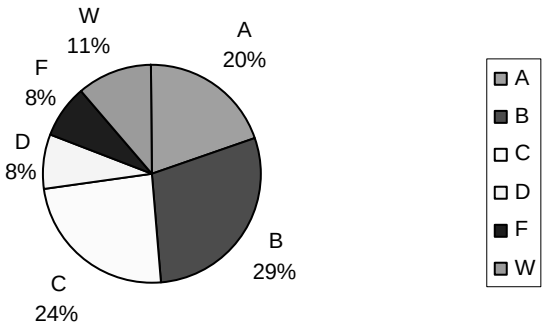
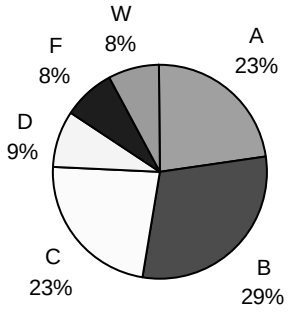


Figure 2. Grades Post the New Technology Requirements



of the students did not pass the course. The data for classes, with technology, improved to 16% (18/114) not passing. While the percentage of F grades remained very close, the first is above 8% (14/171) while the second is below 8% (9/114) so this is a very slight improvement. The data regarding fewer students dropping the course gives the most positive contribution. Without technology 11% (19/171) of the students choose to W, while only 8% (9/114) withdrew after the technology became available which may be interpreted as supporting the idea that marginal students benefit from the extra help. Though these measures are not statistically significant, they indicate that the time and effort devoted to developing the course is worthwhile because both teachers and students are happier with the course as is evidenced by the course evaluation averages improving from a rating of 3.53 (n=81), out of a possible 5, to 3.84 (data available for n=41). Fortunately, there seems to be an absence of negatives to this incorporation of technology.

Conclusions

Online homework. The time-and-effort grades prior to the new technology requirements were mostly a measure of the quantity of effort students put into the course. With the new technology, the time-and-effort grades now include a good measure of the quality of students' effort. The students now seem more confident about their own mathematical competence and ability to learn. I attribute this to their homework practice and learning experiences with the new technology.

Online grade book. Instead of having the computer show the homework grade based on attempted work, I highly recommend that teachers use the settings to assign a zero for all homework assignments not attempted so that students have a realistic evaluation of their homework grade. It may even stimulate some students to complete more problems in order to reach their pre-set grade choice. When I enter the test grades as an offline item I update the other half of my students' time-and-effort grade which I now call "Attendance, class work, etc." as an offline item. Students checking for their new test grade will also see their current average in the course.

Satisfaction. Teachers and students are satisfied with the new online materials. While the homework and test banks are not as extensive as the textbook problems, these will be augmented and improved over time.

Though clarifications and alternate explanations are occasionally requested in class, there is far less class time spent going over homework questions. This is a positive result since there is less time spent on boring the students who did not have difficulty with that material and thus enhancing the course experience. Also, this frees class time to explore further materials. Incorporating the homework, grade book, and test bank into the course can be done gradually as a teacher increases their comfort level with the materials. I highly recommend that other teachers explore, utilize, help expand and improve their textbook publisher's available online materials.

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