# ACHIEVEMENT AND ATTITUDES IN DEVELOPMENTAL MATHEMATICS

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## ABSTRACT

*A mathematical manipulative is an object which is designed so that a student can learn some mathematical concept by manipulating it. The use of manipulatives provides a way for children to learn concepts in developmentally appropriate, hands-on ways. Mathematical manipulatives are used in the first step of teaching mathematical concepts, that of concrete representation. The second and third step are representational and abstract, respectively.*

*Mathematical manipulatives can be purchased or constructed by the teacher. Examples of commercial manipulatives include Tangrams; Cuisenaire rods; Numicon patterns; Diene's blocks; interlocking cubes; base ten blocks; pattern blocks; colored chips; links; fraction strips, circles, blocks, or stacks; and geoboards. Examples of teacher-made manipulatives used in teaching place value are beans and bean sticks or bundles of ten Popsicle sticks and single Popsicle sticks.*

## INTRODUCTION

In fall semester 2006, about 50% of the incoming freshman class at The Gujarat University were required to take a mathematics course, consisting of material covered in pre-high school curriculam (these types of courses are referred to as developmental). Research indicated that high enrollment in developmental classes has occurred throughout colleges and universities in United States and that large numbers of these students were not successfully completing these courses. With the advent of increasingly sophisticated computer technology, schools such as The Gujarat University have incorporated supplemental web-based programs such as MathXL* in their developmental mathematics courses.

This led to the need to research the following two questions:

1. Did the use of MathXL in Intermediate Algebra at The Gujarat University impact students' mathematics achievement in Intermediate Algebra as well as in subsequent mathematics courses?
2. Did the use of technology change students' attitude towards mathematics over the course of one semester, fall 2006?

MathXL is an on-line homework, tutorial, and assessment system designed specifically for Pearson Education textbooks in mathematics and statistics. MathXL provides immediate affirmation and/or corrective feedback, ensuring that a student's last response is the correct one. MathXL creates personalized study plans for students based on their test results and offers unlimited (algorithmically generated) practice exercises correlated directly to the exercises in the textbook. MathXL is designed to be used in a lecture, self-paced, or distance-learning course.

## LITERATURE REVIEW

Developmental education or remediation was defined by The National Center for Educational Statistics as the courses in reading, writing or mathematics for college students lacking those skills necessary to perform college-level work at the level required by the institution. Students who needed such developmental or remediation were classified as *underprepared students*. Various topics such as why there was a need for developmental mathematics; how should educators ensure success for underpre-pared students and who was enrolled in developmental mathematics were examined in the literature.

In 2000, over one million underprepared students entered college. Almost 42% of incoming freshmen were not prepared for college level courses, including mathematics courses. In 2002 millions of college students lacked the literacy and mathematics skills needed to learn at the postsecondary level even though they had completed secondary education. By 2004, between 60-75% of entering college freshman required remediation in a college environment. In the period between 2000-2004, the percentage of students enrolled inthese courses increased by 20-35%.
One reason why students entered college underprepared was because many states did not require enough college preparatory courses in mathematics for high school graduation. In fact, students who skipped mathematics in their senior year were out of practice when they took college placement test and often were placed into developmental mathematics. Another reasons the students were underprepared for college level mathematics was that the rigor and content in their high school courses were lacking and varied greatly. For example, school districts had widely different definitions of what constitutes Algebra I. The curriculum content and rigor were different from district to district.

One key feature to ensure success for underprepared students in developmental programs was mandatory assessment and placement. In recent years, success of mandatory assessment and placement for these students in community colleges had been validated, it showed that those who tested into a developmental course and took that course the next semester, persisted at the community college longer and were more successful than similar students who did not enroll in a developmental course.

More than 40% of mathematics courses offered at two-year community colleges were developmental mathematic courses. Only 34% of the students who successfully completed the coursework required continued with college level mathematics courses. The unsuccessful students were likely to leave college unless something was done. Therefore, to promote success for these students was to retain them.

The first aspect of retention to be considered was the approach of teaching and learning that yielded high student persistence in developmental classrooms in the college. Three learning theories were identified for learning in the developmental classroom:

- Humanistic approach where students were responsible for their own learningand the role of the teacher was a facilitator to that learning.
- Programmed instruction such as self-paced learning.
- A supportive, encouraging and challenging atmosphere.

## RESEARCH METHODOLOGY

To examine the use of MathXL in Intermediate Algebra, official grade records of 2,250 students from the 2003 fall semester, 2004 fall semester, 2005 fall semester and 2006 fall semester were analyzed. These students from daytime and evening sections attended the main campus of The Gujarat University and were categorized only by their demographics.

Prior to and during the 2003 fall semester, Intermediate Algebra students only used technology during their monitored in-lab computer-based tests. During the 2004 fall semester, they used MathXL for homework. During the 2005 fall semester, they used MathXL for homework, quizzes and monitored in-lab exams. During the 2006 fall semester Intermediate Algebra students used MathXL for homework and monitored quizzes and exams.

The Intermediate Algebra course was lecture based. Students attended a lecture for three hours a week where attendance was taken on a daily basis. The success rate of students in Intermediate Algebra prior to using MathXL were compared to students' success rate using some MathXL and students' success rate using MathXL completely. Intermediate Algebra was a prerequisite course to college-level mathematics at the university. Students had to earn a grade of C- or above in order to enroll in college-level mathematics and many students repeated Intermediate Algebra.

## RESULTS

The Use of MathXL in Intermediate Algebra at The Gujarat University Impacted Students' Mathematics Achievement in Intermediate Algebra as well as in Subsequent Courses the passing rate (based on a grade of C- or above) was examined for all students enrolled in Intermediate Algebra with the use of MathXL and without the use of MathXL. From 2003-2006 fall semesters, the passing rates were separated between students who were enrolled in Intermediate Algebra for the first time (first-time) and students who had enrolled in Intermediate Algebra previously (repeating): these groups were separated based on student demographics.

*Table (4.1) presents the percentages of all students passing Intermediate Algebra.*

| Year | First Attempt Students Passed/Completed = % | Previous Attempt Students Passed/Completed = % | Total Students Passed/Completed = % |
|---|---|---|---|
| 2003 | 294/530 = 55.47% | 36/117 = 30.77% | 330/647 =51.00% |
| 2004 | 256/406 = 63.05% | 53/135 = 39.26% | 309/541=57.12% |
| 2005 | 211/390 = 54.10% | 29/92 = 31.52% | 240/482=49.79% |
| 2006 | 272/463 = 58.75% | 21/62 = 33.87% | 293/525=55.81% |

*Table (4.2) presents the percentages of all female students passing Intermediate Algebra.*

| Year | First Attempt Students Passed/Completed = % | Previous Attempt Students Passed/Completed = % | Total Students Passed/Completed = % |
|---|---|---|---|
| 2003 | 132/245 = 53.88% | 20/61 = 32.79% | 152/306=49.67% |
| 2004 | 135/213 = 63.38% | 27/73 = 36.99% | 162/286=56.64% |
| 2005 | 106/187 = 56.68% | 16/46 = 34.78% | 122/233=52.36% |
| 2006 | 142/220 = 64.55% | 25/59 = 42.37% | 167/279=59.86% |

*Table 4.3: Male Students Passing Intermediate Algebra*

| Year | First Attempt Students Passed/Completed = % | Previous Attempt Students Passed/Completed = % | Total Students Passed/Completed = % |
|---|---|---|---|
| 2003 | 162/285 = 56.84% | 16/56 = 28.57% | 178/341 = 52.20% |
| 2004 | 121/193 = 62.69% | 26/62 = 41.94% | 147/255 = 57.65% |
| 2005 | 105/203 = 51.72% | 13/46 = 28.26% | 118/249 = 47.39% |
| 2006 | 130/243 = 53.50% | 24/58 = 41.38% | 154/301 = 51.16% |

The results indicated that compared to the total population, by week 15, the attitude of the students who completed a survey three times during the semester had a positive attitude of 10 compared to 9.06. The upperclassmen had the most positive attitude by the 15th week at 10.62.

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