

The Effects of Developmental Mathematics on Student Performance at an Open Admissions University

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NCES (1996) reported that almost one-third of all students entering colleges and universities are unprepared for college coursework and therefore required to enroll in developmental courses. This study focused on developmental and regular mathematics courses at the University of Arkansas at Monticello. Using final mathematics grades from the freshman cohort of 1994, the Mann-Whitney U-test was run to compare final grades in college-level mathematics courses between the students who were first enrolled in developmental mathematics and students who were not. The chi-square test was used to determine whether any difference existed in retention and graduation rates between students who completed their developmental mathematics courses in one year and students who did not.

The study showed that there was no statistically significant difference in final grades in college level mathematics courses between students who took developmental mathematics courses upon arrival to campus and students who did not. However, a difference was detected in retention and graduation rates between students who finished their developmental mathematics courses in one year and students who did not.

Mathematics is a universal language. While verbal languages differ among geographical regions, mathematics is the language that doesn't discriminate. Mathematics provides the necessary background for the more technological skills that today's workforce demands. Moreover, mathematics gives students the tools for problem solving and reasoning. Sequential, logical thinking skills are honed in the mathematics classroom, giving students a means by which they can improve critical thinking and approach problems.

Unfortunately, the National Center for Educational Statistics (NCES) reported that in the year 2000, only 17 percent of high school graduates were considered 'proficient' in mathematics. 'Proficient' is defined as the level of intellect expected of a high school graduate (NCES, 2001). Furthermore, the Third International Mathematics and Science Study-Repeat (TIMSS-R)

report of 1999 showed American students ranked about 20th among the 38 countries that were involved in the study (NCES, 2001).

The downward trend in mathematics and science proficiency has been consistent since the launching of Sputnik in 1957 (Goodstein, 2001). As the nation's schools continue to witness the decline of mathematical abilities, institutions of higher education inevitably inherit the predicament. In 1998, approximately 15 million students enrolled in institutions of higher education (NCES, 2001). Since the number of developmental students entering higher education has been a consistent 30 percent of the enrollment for several years, it is unlikely that retention of these students would be possible without some developmental coursework. Boylan (1999) reported that students who successfully completed their developmental coursework were prone to return to college after their freshmen year and eventually to graduate. Admittedly, the time that the developmental coursework takes is time added to a student's college career. However, such coursework is pertinent in building a strong foundation in basic, fundamental skills. Without developmental programs, the nation could very well witness a thirty percent reduction in college enrollment.

THE STUDY

Monticello, Arkansas is located in the Southeastern corner of the state not far from the Mississippi Delta and has a population of approximately 10,000. The University of Arkansas at Monticello (UAM) has been an open-admissions institution since it opened its doors in 1909. Today, UAM is the only remaining open-admissions university in Arkansas.

The intention of the open-door policy is to make a college education available to anyone who desires it. That policy tends to promote a student body that is diverse in race, economic background, and intellectual level. The average score on the American College Test (ACT) for entering freshmen at UAM is approximately 19.60 (Bryant, 2001). Arkansas law requires that public colleges and universities remediate any student with an ACT score below 19. At UAM, that encompasses 46 percent of the enrollment.

UAM offers two developmental mathematics courses. Entering freshmen with a mathematics ACT score of 15 or below are required to enroll in Introductory Algebra. This is the most basic developmental mathematics course offered at UAM and covers rudimentary mathematics skills and basic algebraic concepts. Students that enter their freshmen year with a mathematics ACT score of 16-18 are required to enroll in Intermediate Algebra, a class that serves to prepare students for one of the freshman level mathematics courses by strengthening their skills in graphing functions, factoring polynomials, and using hand-held technology. Students with mathematics ACT scores of

19 and above are eligible to enroll in a freshman level mathematics course, such as College Algebra, Survey of Mathematics, or Trigonometry, any one of which meets the graduation requirement. Therefore, students required to take developmental mathematics courses must take them sequentially. It should also be noted that students are allowed to voluntarily remediate. For example, the student with a mathematics ACT score above 19 may opt to take Intermediate Algebra if he or she is unsure of his or her math skills.

While the success rate among developmental mathematics students at UAM has traditionally been approximately 46 percent, the success rate of those students in the college-level mathematics course, College Algebra, has been approximately 50 percent. Since UAM is an open admissions university, discussion has arisen on strategies for increasing the success rate of the College Algebra course. The purpose of this study was to examine the developmental education program at UAM. The questions that were addressed and clarified by the research are the following:

1. Are students who successfully pass Intermediate Algebra in their first attempt more likely to successfully complete College Algebra/Survey of Math than those who do not?
2. Are students who complete Intermediate Algebra with a grade of B or better more likely to successfully complete College Algebra/Survey of Math than those who complete Intermediate Algebra with a grade of C?
3. Are students who take and successfully complete Intermediate Algebra more likely to successfully complete College Algebra/Survey of Math than those students who were not required to take Intermediate Algebra?
4. Are students who successfully complete their developmental coursework in one year more likely to be retained the following year?
5. Are students who successfully complete their developmental coursework in one year more likely to graduate than those who do not?

The nature of this study was conducive to quantitative research and analysis. The data was information that had previously been collected on the 1994 freshman class at the University of Arkansas at Monticello. The data was obtained from the institutional research officer at UAM, and statistical analyses were conducted on that information to test the hypotheses. The data that was analyzed were the final mathematics grades received by the students and their successful or unsuccessful attempts at a bachelor's degree.

The participants of this study were the freshmen students that entered the University of Arkansas at Monticello in the fall of 1994. Only first semester freshmen were studied and no distinction was made between full-time students and part-time students. A total of 523 students comprised the population of this study and grades from the subsequent spring semester were collected on this same cohort of students. Of the 523 freshmen who began

their higher education at UAM, 411 returned for the spring semester of 1995. That is approximately a 78.6 percent retention rate. The average grade point average attained by this group of students was a 2.45 on a 4.00 scale.

RESULTS

Research question one asked whether students who successfully pass Intermediate Algebra in their first attempt are more likely to successfully complete College Algebra/Survey of Math than those who do not.

The Mann-Whitney U-test, a nonparametric alternative to the standard t-Test, was conducted on the data for this question. The information obtained on this cohort of students was their final grade in College Algebra/Survey of Mathematics. Students with a final grade of 'A' in the college level mathematics course were assigned the number '4', students with a final grade of 'B' in the college level mathematics course were assigned the number '3', etc. The results of this test supported the null hypothesis that there was no difference between the College Algebra/Survey of Math grades of the students who successfully completed Intermediate Algebra in their first attempt and those who did not. The findings indicated that there was no difference.

Research question two asked whether students who complete Intermediate Algebra with a grade of 'B' or better are more likely to successfully complete College Algebra/Survey of Math than those students who complete Intermediate Algebra with a grade of 'C'.

Again, the Mann-Whitney U-test was used. The test results rejected the null hypothesis that there was no significant difference in the final grades in College Algebra/Survey of Math between the students who completed Intermediate Algebra with an 'A' or 'B' and the students who completed Intermediate Algebra with a grade of 'C'. This means that the students who completed the developmental mathematics course with a 'C' did not do as well in their college level mathematics course as the students who completed the developmental mathematics course with an 'A' or 'B'. (Note: The justification behind the grade of 'C' being a point of reference was that students are not allowed to exit the developmental curriculum without a minimum grade of 'C'.)

Research question three asked whether students who take and successfully complete Intermediate Algebra are more likely to successfully complete College Algebra/Survey of Math than those students who were not required to take Intermediate Algebra.

Using the Mann-Whitney U-test, the results showed that the null hypothesis, that there was no significant difference in the median final grades in College Algebra/Survey of Math between students who were required to take

a developmental mathematics course and those students who were not, could not be rejected. This test shows that the students who took developmental mathematics in preparation for their college level mathematics course differed very little in their final grades in that college level mathematics course from the students that were allowed to enroll in College Algebra/Survey of Math during their first semester.

Research question four asked whether students who successfully complete their developmental coursework in one year are more likely to be retained the following year.

The data was analyzed using the chi-square test. The students who were used in this test were the 366 students that began their first semester of college in a developmental mathematics course. The students who completed their developmental courses in one year were assigned the number '1' and the students who did not complete the developmental courses in one year were assigned the number '2'. The same numbers were assigned for the students who returned the next fall and the students who did not return. The test showed that the null hypothesis, that there was no difference in the number of students retained who did complete their developmental coursework in one year and the number of students retained who did not complete their developmental coursework in one year, could be rejected. However, the effect size in this test was approximately .12. This means that while a difference was detected, it may not be significant enough to warrant any change in policy or practice.

The final research question asked whether students who successfully complete their developmental coursework in one year are more likely to graduate than those who do not.

The test used to measure this data the chi-square test. The students who were used in this test were the 366 students who were enrolled in a developmental mathematics course during the fall semester of 1994. The chi-square test showed that the null hypothesis, that there was no statistically significant difference between the number of students who graduated who had successfully completed their developmental coursework in one year and the number of students who graduated who did not successfully complete their developmental coursework in one year, could be rejected. A difference was detected with an effect size of .31, making the results a bit more substantial.

DISCUSSION

The purpose of this study was to closely examine the developmental education program at UAM to determine whether the developmental courses were adequately preparing the students for a college level curriculum. Conducting this study was both informative and enlightening. This study portrayed a

dire state for developmental students in our institution. The retention rate of developmental students is discouraging. The graduation rate of developmental students is even more disappointing. In the fall of 1994, there was an approximate 16 percent graduation rate among the 366 students that started their college careers in a developmental mathematics course. However, in light of the study, for those students that successfully completed their developmental coursework in one year, there was a significant difference in their graduation rate.

The results of the study could have far-reaching implications on the developmental education program at UAM. One proposal that has been suggested for increasing success among the college-level mathematics courses has been to raise the grade of successful completion of a developmental course from a C to a B. The study showed that a student's final grade in his developmental mathematics course did impact the student's final grade in his college-level mathematics course. Thus, the idea that raising the standard in the developmental mathematics courses from a C to a B has some merit since it may positively affect the success rate in college level mathematics courses.

Boylan and Bonham (1994) posited that students who take developmental courses may be more prepared for a college level curriculum. The results of this study showed that there was no difference in the college level mathematics grades between the students at UAM who took developmental mathematics courses and the students who did not. In other words, developmental students enter the institution underprepared, but yet after successfully completing the developmental program, are able to compete with college level students who were not required to enroll in developmental courses. In fact, the mean final grades in the college level mathematics courses between the two groups were extremely close.

The study did show that there was a difference in retention between students who completed their developmental mathematics course in one year and those who took longer. The retention rate was higher among the group that did successfully complete their developmental coursework in one year. To answer the question that many have asked: Is it wise then to require students to take their mathematics course immediately upon arrival at UAM? This study shows that, yes, requiring students to enroll in that developmental mathematics course and requiring their continuous enrollment until its completion is in the best interest of the student.

As a rule, students at UAM must be continuously enrolled in their mathematics and English courses, whether developmental or freshmen level courses, until they complete the general education requirements for any degree. This issue has been under scrutiny by students, parents, and faculty members

since its adoption. Many have argued that this rule forces students to enroll in courses that they are not yet required to take and therefore may discourage them from returning to school the next year. However, this study showed that students who enrolled and successfully completed their developmental coursework in their first year were more likely to return the following year.

Possibly the strongest argument for the requirement of the continuous enrollment in the freshman mathematics course is the result of research question five. These results depicted a higher graduation rate of students who completed their developmental coursework in one year when compared to students who took longer. In a time when the national economy depends on a skilled workforce, earning a college degree appears to be more important than ever. The community of higher education witnesses an approximate 30 percent of its freshmen entering college lacking the skills for college level coursework each fall (NCES, 2001). While the responsibility of educating tomorrow's workforce is not solely that of higher education, it is a responsibility that nevertheless befalls them.

Institutions of higher education may not have the cure for preventing skills deficiencies in our mathematics students. However, this study indicated that by strengthening some of the basic skills that so many college freshmen are lacking, developmental educators can give their students an advantage in either pursuing a college degree or entering the workforce. Either way, the knowledge imparted is invaluable and the contribution to society is precious.

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