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Differences in Developmental Education Enrollment and Mathematics Performance at Texas 4-Year Universities: A Multiyear, Statewide Study

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ABSTRACT

In this study, the numbers and percentages of students enrolled in developmental education in mathematics at Texas 4-year universities were calculated for the 2002-2003 through the 2009-2010 academic years. Determined in this investigation were the increases and decreases in the numbers and percentages of students enrolled in developmental education in mathematics and whether differences were present in these statistics over an 8-year time period. A particular emphasis in this investigation was on the completion of a college-level course in mathematics by students who were enrolled in developmental education in mathematics. Revealed in this multiyear investigation were statistically significant differences in the numbers of students enrolled in developmental education in mathematics and in the percentages of those students who then completed a college-level course in mathematics. However, the percentages of students enrolled in developmental education in mathematics were not statistically significant over time. Although the numbers of students enrolled in developmental education in mathematics decreased over time, about 60% did not complete a college-level course in mathematics. Readers are provided with implications for practice and recommendations for future research.

Keywords: *Developmental education, mathematics, Texas, 4-year universities, college-level course*

INTRODUCTION

Earning a college degree is an increasingly expensive endeavor. Since the mid 1980s, the college education inflation rate has risen a staggering 500%, while the consumer price index has increased a mere 115% (Odland, 2012). Despite recent criticisms and concerns about the exorbitant cost of college, college graduates continue to enjoy its benefits by having "larger earnings over a lifetime, lower unemployment rates, better health, higher marriage rates, and greater civic involvement" (Rose, 2013, p. 25). A Pew Research Center (2011) survey indicated that 94% of adults had the expectation their own children would attend college, and 86% of adults confirmed their own college degrees were money well spent. Regardless of its high price tag, a 4-year college degree continues to be a part of the coveted American Dream, the desire for financial independence, home ownership, and sustainable employment.

Recent statistics regarding the benefits of a college degree support these ideas. The National Center for Education Statistics (2013) reported that an individual age 25-34 with a bachelor's degree, the rate of unemployment in 2012 was only 4.1%. In contrast, nearly 13% of that same age group lacking a college degree was unemployed. Karageorge (2014) agreed that tolerance for the cost of a college degree was due to its continued success as a valuable asset. Between 1970 and 2013, individuals who held a bachelor's degree earned an average of 56% more than high school graduates. Gee and Hawk (2015) identified even less obvious benefits of a college degree. College graduates are more likely to read to their own children, have lower rates of obesity and smoking, and are less likely to be incarcerated (Gee & Hawk, 2015). Therefore, achieving a college degree contributes to a society that is employed, financially stable, health conscious, and family oriented.

COLLEGE READINESS IN MATHEMATICS

College readiness, or the lack thereof, is hindering the pursuit of a 4-year college degree for many students. The ACT (2013) reported that only 25% of students were college ready. Gallard, Albritton, and Morgan (2010) emphasized

that college readiness is one of the most critical factors in predicting students' abilities to experience success during college. However, with at least half of all entering college students unprepared for college course work (Bailey, 2009), and 20% of 4-year college entrants requiring remedial education and dropping out after only one year (Steinberg, 2014), college-readiness is a crisis.

Abraham, Slate, Saxon, and Barnes (2014) recently investigated the college-readiness crisis specifically as it pertains to mathematics. Abraham et al. (2014) documented that nearly 42% of Texas college students in 2008 were not college ready in mathematics. Unfortunately, over a 3-year period, a lack of any substantial increase in college-readiness scores in mathematics for students who were first time in college (FTIC) was demonstrated, indicating that readiness efforts attempted by K-12 and college educators were unsuccessful. In contrast, FTIC students who were college ready in mathematics had a much higher rate of passing a college-level mathematics course within one year than FTIC students who were not college ready (Abraham et al., 2014). Differences in college readiness in mathematics could likely affect student success, persistence rates, and graduation rates.

Other researchers (e.g., Barnes & Slate, 2011; Barnes & Slate, 2013; Combs et al., 2010; Saxon, Slate, & Barnes, 2015) have also determined that college-readiness in mathematics is in crisis. Saxon et al. (2015) documented that only about 40% of Texas college students met the state's mathematics readiness standard in 2007. When considering students by ethnicity/race, Black and Hispanic students have statistically significantly lower college readiness rates in mathematics than do White students (Barnes & Slate, 2011). Focusing on student gender, Combs et al. (2010) established that boys scored higher on examinations measuring college readiness in mathematics than girls, which presents a worrisome gap of achievement. Finally, Barnes and Slate (2013) suggested that America's effort to keep pace with global scientific and technological achievements in the 1950s and 1960s was one cause for current ineffective college-readiness measurements in mathematics. These well-intentioned efforts led both to misguided policies for measuring college readiness and to lacking remedies for improving college readiness in mathematics.

Proficiency in mathematics is one critical area where American college students are ill-equipped for college-level courses. Hodara (2013) suggested that several interventions were necessary to improve mathematics college readiness among U.S. students, including better pre-matriculation programs for high school students, reformed developmental mathematics programs, and new teaching strategies in mathematics classrooms. Lacking mathematics skills could have serious implications for American workers in a competitive global economy where mathematical skills were often required when applicants seek jobs (Bailey & Borwein, 2012; Carnegie Institute, 2009). College students and graduates must be well prepared for a job force that demands adept mathematical skills or they risk being left behind in a changing economy.

Some educators and administrators blame secondary institutions for college-readiness deficiencies. Harrigan and Davies (2012) contended that a high school education "is now wasted taxpayer money; another $80,000 investment is necessary to cover college tuition and fees. And a healthy portion of this investment is spent teaching college students what they should have already learned" (p. 1). Steinberg (2014), a psychology professor at Temple University and a harsh critic of American high schools, reported that over the last 40 years, 17-year-old high school students have made no progress on their mathematics subject-area tests. In an effort to raise high school accountability, state agencies are requiring higher standards and increased reported of specific indicators. In Texas, the Texas Education Agency (2016) has called for the reporting of college-readiness indicators and set criteria for grading school campuses based on their successes achieving the indicators. However, many of these efforts by states continue to fail to increase the numbers of students who are college ready.

Poor mathematics performance in college may be linked to other factors related to secondary schools. The onset and popularity of block scheduling was one reason cited. Zelkowski (2010) suggested that mathematics students experienced detrimental breaks in their instruction with block scheduling, which oftentimes allowed students to take a mathematics class only once a year and for one semester. This months-long interruption could inhibit continuous mathematics instruction for struggling students. Furthermore, lacking college readiness in mathematics may be caused by student inability to achieve mastery in basic high school courses, such as algebra. Corbishley and Truxaw (2010) noted results of a mathematics faculty survey that provided some

indication about the severity of inadequate college readiness among students. According to faculty surveyed, only about 9% believed that their freshmen students were prepared for their first mathematics course. One faculty member replied that "Too many need to retake second, and even first, year high school algebra. Those who don't need those remedial classes are typically just adequate in algebra skills except incoming math and science majors" (Corbishley & Truxaw, 2010, p. 76). Latterell and Frauenholtz (2007) reported that college readiness in mathematics was a complex issue and rooted in a variety of causes.

Persistence as a Function of Developmental Education

A large portion of higher education institutional planning is centered on retaining students (Claybrooks & Taylor, 2016). Student persistence, which refers to students transitioning from one year to the next year (Texas Higher Education Coordinating Board, 2012), is at a crossroads in higher education. At 4-year public institutions, the dropout rate is 42%, indicating that within six years, first-time, full-time students had not graduated with a bachelor's degree. At less selective institutions with open admissions, the dropout rate is even higher at 63% (National Center for Education Statistics, 2016). When considering students by ethnicity/race, dropout rates among Hispanic and Black students are alarmingly high and exceed the dropout rates of White students (Spangler & Slate, 2015). Two reasons cited for the higher dropout rates of Hispanic and Black students are financial challenges and family obligations (Witkow, Huynh, & Fuligni, 2015). Therefore, colleges invest many resources to determine how to improve student retention for a diverse student population.

Strategies to enhance student persistence range from the required first-year experience course to extensive efforts to integrate students into college social and academic life (Claybrooks & Taylor, 2016). Because so many students arrive on college campus lacking academic skills, institutions focus on remediation as one method to retain students to improve persistence (Stewart, Lim, & Kim, 2015). Developmental education courses are a primary component of focused remediation. The goal of these courses is to improve academic proficiency so that students could enroll in credit-bearing courses. However, Clark, Slate, Moore, and Barnes (2015) determined that developmental education did not positively influence persistence or graduation rates over a 3-year period for White, Black, and Hispanic students. Through a review of the literature, Clark et al. (2015) identified several developmental education challenges, including inconsistencies about the definition of college readiness, unreliable placement test scores as the sole indicator of college readiness, and debates about whether high schools or colleges should deliver developmental education. Also, Abraham et al. (2014) documented that over a 3-year period, the average mean percentage of students who had taken a developmental mathematics course and then passed a college-level mathematics course with at least a "C" was less than 6%. When Abraham et al. (2014) examined college readiness in one of those years, 2008, nearly the same percentage of FTIC students were deemed college ready in mathematics as FTIC students who were enrolled in developmental courses in mathematics. Therefore, discrepancies exist between high school and college definitions of college readiness. Unfortunately, students taking developmental courses were much less likely to complete college with a degree than were students who never required developmental education (Bailey, Jeong, & Cho, 2010). Developmental education courses as a strategy to improve persistence and retention have been unsuccessful for most students.

To improve persistence rates as a result of developmental education courses, institutions are attempting different formats. One method attempted is to provide students the opportunity to take developmental courses and college-level course concurrently (Mangan, 2014). Also, expediting the time frame and reorganizing the curriculum into a more compact design is another method of developmental courses used by some institutions (Edgecombe, 2011). These accelerated courses allow students to complete both the developmental course portion while completing the college-level course requirements (Jaggars, Hodara, Cho, & Xu, 2015). Reforms such as the accelerated developmental courses require faculty to design courses with end goals in mind and to determine evidence of achievement in advance (Walker, 2015). These new methods of delivery hold promise to improve persistence rates among the most struggling students.

Statement of the Problem

The President's Council of Advisors on Science and Technology (2017) called for an improvement in student skills in science, technology, engineering, and mathematics (STEM) to keep pace in an economically competitive society and for 100,000 teachers to be trained in STEM over the next decade. This plea may originate in the fact that only 44% of high school graduates in 2013 were college ready in mathematics (National Math Science Initiative, 2016). To that end, an imperative exists to improve college readiness in mathematics.

Hispanic and Black students, in particular, need additional support and different teaching styles at both the secondary and postsecondary levels to achieve college-level proficiency in mathematics (Houser & An, 2015). Unfortunately, many Hispanic and Black students attend high schools with scant resources and unqualified teachers, making mathematics achievement a difficult task (Atuahene & Russell, 2016). Foltz, Gannon, and Kirschmann (2014) suggested more Hispanic and Black students should be encouraged to choose STEM majors by utilizing enhanced and varied recruitment and persistence efforts.

Struggling students with poor mathematics skills rely on developmental education courses to improve their proficiency so they can progress to college-level mathematics courses. However, developmental courses are largely unsuccessful for many students (Bailey et al., 2010). In 2008, nearly 95% of Texas students who completed a developmental mathematics course could not pass a first-year, college-level mathematics course (Abraham et al., 2014). Although remediation in mathematics is needed, only marginal success has been achieved through developmental education courses.

Purpose of the Study

The purpose of this research study was to identify the numbers and percentages of students who were enrolled in developmental education in mathematics at Texas 4-year universities during the 2002-2003 through the 2009-2010 academic years. A second purpose was to determine the degree to which the numbers and percentages of students who were enrolled in developmental education in mathematics changed from the 2002-2003 through the 2009-2010 academic years in Texas 4-year universities. A third purpose was to ascertain the extent to which student completion of a college-level course in mathematics changed between the 2003 and the 2010 academic years. The final purpose of this research study was to determine the degree to which a trend might be present both in the numbers and percentages of students who were enrolled in developmental education in mathematics, as well as in student completion of a college-level course in mathematics, during the 2002-2003 through the 2009-2010 academic years. Given the importance of improving mathematics readiness and student retention, an imperative exists to determine the relationship between developmental course enrollment in mathematics and student success.

Significance of the Study

Few researchers have focused their efforts on the relationship between developmental course enrollment in mathematics and college-level mathematics course completion at Texas 4-year universities over time. Subsequently, trends in achievement and persistence can be determined by examining the differences in student performance of those individuals who enroll in a developmental mathematics course and then their ensuing completion of a college-level mathematics course. Educational leaders at both the secondary and postsecondary levels may identify possible strategies for combatting lacking college readiness in mathematics. Because many of the 21st century employment opportunities will demand mathematics proficiency, an imperative exists to improve college readiness in mathematics. By determining the connection between developmental course enrollment in mathematics and student persistence by way of college-course completion, focused decision making by educational leaders regarding remediation efforts and developmental course design can be improved, and students can achieve success by persisting and graduating.

Research Questions

In this investigation, the research questions examined were:

- What are the numbers of students who were enrolled in developmental education in mathematics at Texas 4-year universities for the 2002-2003 through the 2009-2010 academic years?;
- What are the percentages of students who were enrolled in developmental education in mathematics at Texas 4-year universities for the 2002-2003 through the 2009-2010 academic years?;

- What is the difference in the average number of students who were enrolled in developmental education mathematics at Texas 4-year universities between the 2002-2003 and 2009-2010 academic years?;
- What is the difference in the average percent of students who were enrolled in developmental education mathematics at Texas 4-year universities between the 2002-2003 and the 2009-2010 academic years?;
- What are the percentages of students who were enrolled in developmental education in mathematics and completed a college-level course in mathematics in the 2002-2003 through the 2009-2010 academic years?;
- What is the difference in the percentage of students who were enrolled in developmental education mathematics at Texas 4-year universities and who completed a college-level course in mathematics between the 2002-2003 and the 2009-2010 academic years?;
- What trend is present, if any, in the numbers of students who were enrolled in developmental education in mathematics at Texas 4-year universities during the 2002-2003 through the 2009-2010 academic years?;
- What trend is present, if any, in the percentages of students who were enrolled in developmental education in mathematics at Texas 4-year universities during the 2002-2003 through the 2009-2010 academic years?; and
- What trend is present, if any, in the percentages of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics at Texas 4-year universities during the 2002-2003 through the 2009-2010 academic years?

METHOD

Research Design

A longitudinal, explanatory design was utilized for this research article (Johnson, 2001). In this study, the individual variables had already occurred and extraneous variables were not controlled (Johnson & Christensen, 2012). Archival data from the Texas Higher Education Coordinating Board were utilized to examine the previously mentioned research questions. Accordingly, the independent variables in this research article were the academic years: 2002-2003 through 2009-2010. The three dependent variables were the number of students enrolled in developmental education mathematics courses, the percentage of students enrolled in developmental education mathematics courses, and the percentage of students who passed a college-level mathematics course with an A, B, or C.

Participants and Instrumentation

Archival data from the 2002-2003 through the 2009-2010 academic years were downloaded from the Texas Higher Education Coordinating Board Interactive Accountability System (2016). These data reflected all students at Texas 4-year universities who were first enrolled in a developmental education course and subsequently enrolled in a college-level course in mathematics. The success of students based on developmental course enrollment in mathematics and passing a college-level course in mathematics was analyzed from data collected from 4-year universities in Texas from the 2002-2003 through the 2009-2010 academic years. Data were not available for some universities in some instances; however, all available data were analyzed.

The Texas Higher Education Coordinating Board Interactive Accountability System (2016) data were used for this research study. This system is used to track performance of Texas universities on important matters in higher education. For this research investigation, data were analyzed that specifically pertains to students enrolled in developmental education courses in mathematics at 4-year Texas universities. Developmental education is defined by the Texas Higher Education Coordinating Board as "courses, tutorials, laboratories, or other efforts to bring students' skill levels in reading, writing, and mathematics to entering college level" (2012, p. 25). Only those college-level courses completed with a grade of A, B, or C were analyzed. Regarding developmental course completion and subsequent college-level course completion, inferential statistical methods were used to identify any existing trends from the 2002-2003 through the 2009-2010 academic years.

RESULTS

Regarding the first research question, descriptive statistics were calculated for the numbers of students who were enrolled in developmental education in mathematics at Texas 4-year universities for the 2002-2003 academic year through the 2009-2010 academic year. The 2003-2004 academic year had the most students (n = 9,340) who were enrolled in developmental

education in mathematics. In the 2006-2007 academic year, the fewest number of students (n = 5,912) were enrolled in developmental education in mathematics. In the 2003-2004 academic year, the highest average (M = 291.88) number of students were enrolled in developmental education in mathematics, and in the 2009-2010 academic year, the lowest average (M = 182.72) were enrolled. Readers are directed to Table 1 for these descriptive statistics for the numbers of students who were enrolled in developmental education in mathematics in Texas 4-year universities from the 2002-2003 through the 2009-2010 academic year.

Table1. *Descriptive Statistics for the Number of Students below State Standards in Mathematics at Texas 4-year Universities From the 2002-2003 Through the 2009-2010 Academic Year*

Academic Year	n of 4-year universities	M	SD	Sum
2002-2003	31	289.00	308.72	8,959
2003-2004	32	291.88	319.26	9,340
2004-2005	31	272.94	280.31	8,461
2005-2006	31	243.39	220.81	7,545
2006-2007	31	190.71	181.48	5,912
2007-2008	31	212.32	184.43	6,582
2008-2009	34	209.79	185.37	7,133
2009-2010	36	182.72	179.98	6,578

For the second research question, data available on the Texas Higher Education Coordinating Board Interactive Accountability System were not the percentages of students who were enrolled in developmental education in mathematics. Rather, the available data were percentages of students who were not enrolled in developmental education in mathematics. Reflected in Table 2 are the descriptive statistics for the percentages of students who were enrolled in developmental education in mathematics.

Table2. *Descriptive Statistics for the Percent of Developmental Education Students Who Met the TSI Obligation in Mathematics at Texas 4-year Universities From the 2002-2003 Through the 2009-2010 Academic Year*

Academic Year	n of 4-year universities	M%	SD%
2002-2003	31	46.66	22.93
2003-2004	30	47.74	19.06
2004-2005	30	47.84	19.39
2005-2006	30	37.48	16.74
2006-2007	31	37.17	16.54
2007-2008	31	31.59	18.13
2008-2009	32	40.07	21.95
2009-2010	33	41.11	21.25

Because the second research question was directed at the percentages of students who were enrolled in developmental education in mathematics, average percentages were subtracted from 100% in each academic year. These calculations produced the percentages of students who were enrolled in developmental education in mathematics. In the 2004-2005 academic year, the highest average percentage of students (M = 47.84%) were enrolled in developmental education in mathematics. In the 2007-2008 academic year, the lowest average percentage of students (M = 31.59%) were enrolled in developmental education. Of particular interest was that approximately 41% of students continued to be enrolled in developmental education in mathematics in the most recent academic year of data, 2009-2010.

To answer research question three, inferential statistics were conducted to determine whether differences were present in the average number of students who were enrolled in developmental education in mathematics between the 2002-2003 academic year and the 2009-2010 academic year at Texas 4-year universities. Checks were conducted to determine the extent to which these data were normally distributed (Onwuegbuzie & Daniel, 2002). A decision was made to use a parametric dependent samples t-test to answer the third research question despite some of the values not being normally distributed. Between the 2002-2003 and the 2009-2010 academic years, the parametric dependent samples t-test revealed a statistically significant difference in the average number of students who were enrolled in developmental education in mathematics, $t(30) = 2.72$, $p < .001$. This difference represented a small effect size (Cohen's d) of 0.31 (Cohen, 1988). In the 2009-2010 academic year, nearly 27% fewer developmental education students were enrolled in mathematics than in the 2002-2003 academic year. Table 3 contains the descriptive statistics for this analysis.

Table3. *Descriptive Statistics for the Average Number of Students Who Were Enrolled in Developmental Education in Mathematics in the 2002-2003 and the 2009-2010 Academic Year at Texas 4-year Universities*

Academic Year	n of 4-year universities	M	SD
2002-2003	31	289.00	308.72
2009-2010	31	210.13	179.34

To answer research question four, checks were conducted to determine the extent to which these data were normally distributed (Onwuegbuzie & Daniel, 2002) prior to conducting inferential statistics to ascertain whether differences were present in the average percent of students who were enrolled in developmental education in mathematics between the 2002-2003 academic year and the 2009-2010 academic year at Texas 4-year universities. Even though some of the values were reflective of non-normal data, a parametric dependent samples t-test was used to answer the fourth research question. The parametric dependent samples t-test did not reveal a statistically significant difference in the average percent of students who were enrolled in developmental education in mathematics, $t(29) = -1.35$, $p = .19$ between the 2002-2003 academic year and the 2009-2010 academic year at Texas 4-year universities. The average percentages of students who were enrolled in developmental education in mathematics in the 2002-2003 academic year and in the 2009-2010 academic year were similar, within 6%. Described in Table 4 are the descriptive statistics for this analysis.

Table4. *Descriptive Statistics for the Average Percent of Students Who Were Enrolled in Developmental Education in Mathematics in the 2002-2003 and the 2009-2010 Academic Year at Texas 4-year Universities*

Academic Year	n of 4-year universities	M%	SD%
2002-2003	30	52.62	22.96
2009-2010	30	58.42	21.80

Regarding the fifth research question, descriptive statistics were calculated for the percentages of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics at Texas 4-year universities for the 2002-2003 academic year through the 2009-2010 academic year. The lowest average percentage of these students was 31% in the 2004-2005 academic year and the highest percentage was 44% in the 2008-2009 academic year. Readers should note an increase from the 2006-2007 academic year to the 2009-2010 academic year, where 10% more students completed a college-level course in mathematics. In the last academic year of data analyzed, the percentages of students who had completed a college-level course in mathematics decreased slightly from the previous year. Readers are directed to Table 5 for these descriptive statistics.

Table5. *Descriptive Statistics for the Percent of Developmental Education Students Who Earned a Grade of A, B, or C in a College-level Course in Mathematics at Texas 4-year Universities From the 2002-2003 Through the 2009-2010 Academic Year*

Academic Year	n of 4-year universities	M%	SD%
2002-2003	31	32.12	20.35
2003-2004	30	33.74	15.81
2004-2005	29	31.27	11.68
2005-2006	30	36.42	13.98
2006-2007	31	31.73	10.76
2007-2008	30	41.81	14.17
2008-2009	32	44.02	20.80
2009-2010	34	41.79	16.20

To answer research question six, prior to conducting inferential statistics to determine whether a difference was present in the percentage of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics between the 2002-2003 academic year and the 2009-2010 academic year at Texas 4-year universities, checks were conducted to determine the extent to which these data were normally distributed (Onwuegbuzie & Daniel, 2002). Although some of the values were indicative of non-normally distributed data, a parametric dependent samples t-test was used to answer this research question. A statistically significant difference was yielded in the percentage of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics, $t(29) = -2.63$, $p < .001$, between the 2002-2003 academic year and the 2009-2010 academic year at Texas 4-year universities. This difference represented a moderate effect size (Cohen's d) of 0.60 (Cohen, 1988). In the 2009-2010 academic year, a statistically significantly higher percentage of students were enrolled in developmental education in mathematics and completed a college-level course in mathematics than in the 2002-2003 academic year. Reflected in Table 6 are the descriptive statistics for this analysis.

Table6. *Descriptive Statistics for the Percent of Students Enrolled in Developmental Education in Mathematics at Texas 4-year Universities and Who Completed a College-level Course in Mathematics in the 2002-2003 and 2009-2010 Academic Year*

Academic Year	n of 4-year universities	M%	SD%
2002-2003	30	30.69	19.05
2009-2010	30	40.52	13.27

An analysis of trends of all eight years of data was conducted to answer research questions seven, eight, and nine. With respect to research question seven as shown in Figure 1, trends were present in the average numbers of students enrolled in developmental education in mathematics at Texas 4-year universities for the 2002-2003 through the 2009-2010 academic years. From the 2003-2004 academic year to the 2006-2007 academic year, the average numbers of students enrolled in developmental education in mathematics decreased by 37%. However, the average numbers of students enrolled in developmental education in mathematics increased by over 10% from the 2006-2007 academic year to the final year of this study.

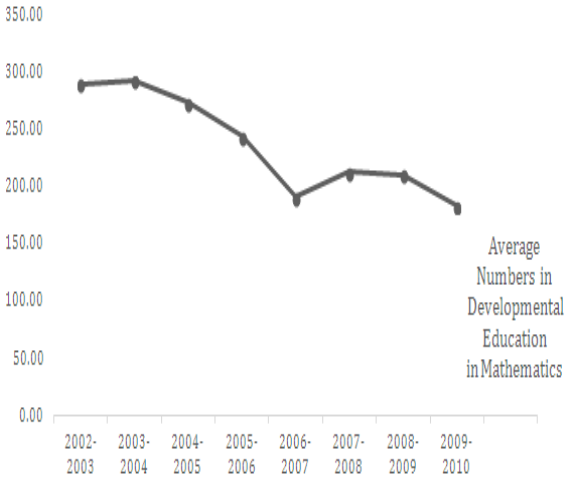

Figure1. *Average numbers of students who were enrolled in developmental education in mathematics at Texas 4-year universities for the 2002-2003 through the 2009-2010 academic years.*

To answer research question eight, trends were present in the average percentages of students who were enrolled in developmental education in mathematics at Texas 4-year universities from the 2002-2003 through the 2009-2010 academic years. As revealed in Figure 2, similar average percentages of students were enrolled in developmental education in mathematics in the first three academic years of this investigation. However, in the 2005-2006 academic year, the average percentages of students enrolled in developmental education in mathematics began to decrease. Over the 8-year period of this study, the 2007-2008 academic year represented the lowest average percentage of students enrolled in developmental education in mathematics, a 34% decrease from the highest average percentage in the 2004-2005 academic year.

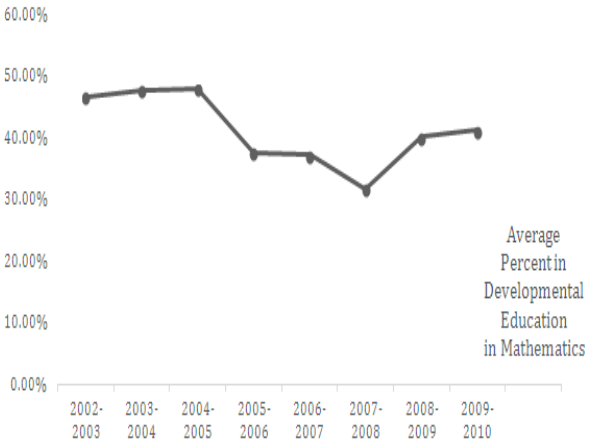

Figure2. *Average percent of students who were enrolled in developmental education in mathematics at Texas 4-year universities for the 2002-2003 through the 2009-2010 academic years*

Regarding research question nine, the average percentages of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics at Texas 4-year universities in the 2002-2003 through the 2009-2010 academic years were determined. As depicted in Figure 3, the average percentages of students were enrolled in developmental education in mathematics and completed a college-level course in mathematics in the first five academic years of this investigation were similar. In the 2007-2008 academic year, however, the average percentage of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics increased 10%. The average percentages of students in the final three years of the study remained approximately 10% higher than those average percentages in the first five years of the study.

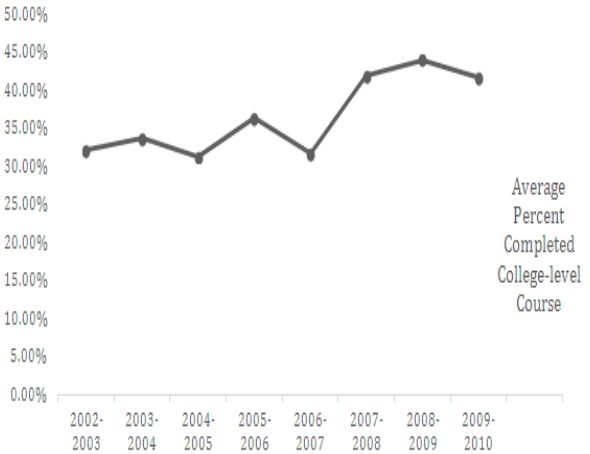

Figure3. *Average percent of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics at Texas 4-year universities for the 2002-2003 through the 2009-2010 academic years*

DISCUSSION

In this investigation, data were analyzed on students who were enrolled in developmental education in mathematics at Texas 4-year universities in the 2002-2003 through the 2009-2010 academic years. Data obtained from the Texas Higher Education Coordinating Board Interactive Accountability System were analyzed over an 8-year period. In this study from the 2002-2003 through the 2009-2010 academic years, at least 29 Texas 4-year universities provided data that were analyzed.

For the eight academic years of data that were analyzed, statistically significant differences were present in the numbers of students who were enrolled in developmental education in mathematics. In this investigation, the average number of students enrolled in developmental education in mathematics was the lowest (n = 5,912) in the 2006-2007 academic year and the highest (n = 9,340) in the 2003-2004 academic year. Statistically significant differences were not present, however, in the percentages of students who were enrolled in developmental education in mathematics. The average percentage of students enrolled in developmental education in mathematics was the lowest, 32%, in the 2007-2008 academic year and the highest, 48%, in the 2004-2005 academic year. Statistically significant differences also were present for the percentages of students enrolled in developmental education in mathematics and who completed a college-level course in mathematics. The average percentage of students who were enrolled in developmental education in mathematics and who completed a college-level course in mathematics was the lowest, 31%, in the 2004-2005 academic year and the highest, 44%, in the 2008-2009 academic year.

Connections with Existing Literature

Previous researchers (Abraham et al., 2014; Chingos, 2016; Hodara, 2013; Latterell & Frauenholtz, 2007; Saxon et al., 2015) have analyzed data on students who were enrolled in developmental education in mathematics. In this multiyear, statewide investigation, the numbers of students enrolled in developmental education in mathematics at Texas 4-year universities decreased by 27% from the 2002-2003 to the 2009-2010 academic year. In this same period, students who were enrolled in developmental education in mathematics and who completed a college-level course increased by 12%. These results were somewhat more positive than the results of Abraham et al. (2015) wherein the numbers and percentages of students enrolled in developmental education in mathematics at community colleges in Texas remained essentially the same over time, showing minimal improvement. In the Abraham et al. (2015) study, only about 5% of students who were enrolled in developmental education in mathematics went on to complete a college-level course in mathematics within three years. This extremely low success rate was interpreted to mean that mandated, state-level initiatives designed to improve mathematics skills for developmental education students at community colleges were failing, and policymakers must reevaluate the efficiency and effectiveness of those initiatives (Abraham et al., 2015).

Implication for Policy and Practice

In this analysis, the numbers and percentages of students enrolled in developmental education in mathematics at Texas 4-year universities decreased from the 2002-2003 academic year to the 2009-2010 academic year. The percentages of students who enrolled in developmental education in mathematics and who completed a college-level course in mathematics increased over time. However, this improvement was only 10% higher over an 8-year period. In the final year of this study, nearly 60% of students had not completed a college-level course in mathematics. Both Texas community colleges and 4-year universities must work more diligently to develop developmental courses in mathematics that provide students with additional opportunities for success in college-level courses.

Abraham et al. (2015) suggested that Texas lawmakers reconsider their stance on Common Core State Standards to ensure that more secondary students are prepared for college-level mathematics. Also, investigations into programs such as the Achieving the Dream Developmental Education Initiative might be in order, considering the improvements in mathematics shown by participating community colleges (Abraham et al., 2015). Chingos (2016) emphasized the importance of quality instruction in college-level mathematics courses as it related to successful student outcomes. Improved faculty evaluation tools may provide feedback that could improve student success in college-level mathematics courses (Chingos, 2016).

Recommendations for Future Research

In this multiyear, statewide investigation, the numbers and percentages of developmental education students in mathematics at Texas 4-year universities were examined. As such, this

investigation could be extended to developmental education students in reading and in writing. These analyses could determine similarities or differences among results reported herein to developmental education in reading and in writing. Although Texas 4-year universities were the focus of this study, researchers should extend the study to 4-year universities in other states. Whether the results delineated herein are generalizable to students in developmental education in other states is not known. Extending this investigation to community colleges would be another suggestion for future research. Would results obtained from community colleges be different when compared to the results of this study? Researchers are also encouraged to extend this study to community colleges in other states.

Student demographic characteristics and their relationships to student enrollment and student success in developmental education were not considered in this investigation.. Researchers are encouraged to examine the extent to which ethnicity/race and gender were related to developmental education student performance. Different types of delivery methods of developmental education exist, such as compressed courses, and researchers are encouraged to investigate the extent to which various methods of delivery is related to student performance.

CONCLUSION

The purpose of this research study was to determine the extent to which differences were present in the numbers and percentages of students enrolled in developmental education in mathematics at Texas 4-year universities from the 2002-2003 academic year through the 2009-2010 academic year. The numbers and percentages of students enrolled in developmental education in mathematics decreased over time; however, the percentages were not statistically significant. Students who were enrolled in developmental education in mathematics and who completed a college-level course in reading increased during the years of the study. Still, nearly 60% of those students did not complete a college-level course in mathematics in the final year of the study. This high percentage of developmental education students failing to complete a college-level course in mathematics is consistent with Abraham et al. (2015). Readers should note that although numbers and percentages of students enrolled in developmental education in mathematics have decreased, many questions and concerns exist regarding why so many of these students are not experiencing higher success rates in college-level mathematics courses.

Saxon et al. (2015) determined that among Texas college students, only about 40% were deemed college ready in mathematics according to the state's readiness standard in 2007. When students attempt to move from developmental courses in mathematics to college-level courses in mathematics, most students are not successful. In a global economy, lack of mathematics proficiency could present challenges for employment opportunities for workers seeking stable, well-paying jobs (Bailey & Borwein, 2012). Universities must take on the formidable responsibility of improving student mathematics skills. Developmental education policymakers must continue to reassess their programs to provide high-quality developmental education for students who struggle in mathematics.

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