DEVELOPMENTAL MATHEMATICS AND STUDENT CHARACTERISTICS THAT CONTRIBUTE TO ACADEMIC SUCCESS AT A TWO-YEAR INSTITUTION IN ALABAMA

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A DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Education in the
Department of Educational Leadership,
Policy, and Technology Studies
in the Graduate School of
The University of Alabama

TUSCALOOSA, ALABAMA

2014

ABSTRACT

This study examined whether a relationship existed between certain student characteristics and academic success at a two-year institution in Alabama. Moreover, the researcher utilized the results to determine the effectiveness of the developmental mathematics classes at the participating institution. In the current higher education environment, administrators and practitioners are called to effectively analyze and report the extent to which programs and classes are meeting the mission of the institution. By using a remediated-exempted research design, developmental classes can be considered effective if the underprepared students perform on par with the students that were prepared for college-level classes. Developmental status, gender, and race were compared with pass/fail status in the first college-level math class, graduation status, grade point average, and continuous enrollment. The data were also aggregated by ACT math subtest scores, COMPASS math subtest scores, and age.

In this research, institutional data was collected for all students that enrolled in MTH 100, the first college-level math course, between fall 2002 and summer 2013. There were 10,003 students that qualified. The following information was collected for the population: age, gender, race, number of terms, term and year enrolled in MTH 100, ACT math subtest scores, COMPASS math subtest scores, cumulative grade point average at time of data collection, graduation status, and academic performance in MTH 100. Tests were run on the data using SPSS and the results were analyzed.

Results from the analyses indicated that the developmental math classes at the participating institution were effective since the developmental students in the study performed as well as the non-developmental group in each of the variables on academic success tested.

Moreover, there was a significant relationship in favor of developmental students in at least one category when compared with MTH 100 pass/fail status, graduation status, grade point average, and continuous enrollment. Current literature is at odds when reporting whether developmental classes are effective (Bahr, 2007, 2010a, 2010b, 2012, 2013; Cullinane & Treisman, Crisp & Nora, 2010; Deil-Amen & Rosenbaum, 2002; Adelman, 2004a; Glenn & Wagner, 2006; Lesik, 2007; Bettinger & Long, 2005, 2009; Kolajo, 2010; Attewell, Lavin, Domina, & Levey, 2006). The results of this study substantiated the claims that developmental classes are beneficial to students that need them since the developmental group performed as well as the non-developmental group when compared to MTH 100 pass/fail status, grade point average, graduation, and continuous enrollment. This study concluded that developmental status, gender, and race were related to student success outcomes of MTH 100 pass/fail status, graduation status, grade point average, and continuous enrollment.

DEDICATION

This dissertation is dedicated to my family who made earning this degree possible. To my husband, Kent, with whom I am so blessed to share my life, thank you for not thinking twice about assuming the role of taking care of our two toddler children and keeping the house for countless weekends. This is to my children, Cole and Kate, for being okay with waiting until I finish typing a sentence for me to throw the football or take my turn in Candy Land. To my mom, Shaun, thank you for helping out with the kids and always giving great advice and reassurance that kept me sane throughout this journey. To my dad, Jeff, I am thankful to you for being my cheerleader and motivator. Thank you to my brother, Beau, for inspiring me to keep trying no matter what. To my grandmother, Faye, I will never forget you being so excited and proud about me earning this degree – you were the motivation that kept me going when I wanted to give up. Thank you to my grandfather, Billy, for finally deciding to call me "Dr. Sara." And thank you to my grandparents, the late J.D. and Gladys Winn, because I know they would have been so proud. I love you all so much and each of you shares a part in this accomplishment.

LIST OF ABBREVIATIONS AND SYMBOLS

ACT	American College Testing
ANOVA	Analysis of variance
COMPASS	Computer-Adapted Placement Assessment and Support Services
ENG 101	English Composition I (first college-level English course)
F	Ratio of the variance of group means to the mean of the within group variances (Fisher's ratio – ANOVA test statistic)
GPA	Grade point average
MTH 090	Basic Mathematics (first developmental math course)
MTH 098	Beginning Algebra (second developmental math course)
MTH 100	Intermediate Algebra (first college-level math course)
MTH 116	Basic Mathematics with Applications (math course for technical degrees)
p	Probability that the test statistic was distributed as it would be under the null hypothesis
SME	Science, mathematics, or engineering
STEM	Science, technology, engineering, or mathematics field
t	Ratio of an estimation of a coefficient to its standard error (*t*-test test statistic)
=	Equal to
$<$	Less than
χ2	Measurement of how expectations compare to results (Chi-square test statistic)

ACKNOWLEDGMENTS

It is with great honor and pleasure that I am able to express my gratitude to the UA faculty/staff, friends, and family who have made this experience possible. First and foremost, I thank Dr. Nathaniel Bray for agreeing to lead me in this endeavor. You might have been taking a chance with me, but I am extremely glad that you did. Thank you for preparing me for each step of the process and for sharing with me your expertise. I would also like to thank each committee member, Dr. David G. Hardy, Dr. Wei S. Hsia, Dr. Margaret King, and Dr. Teresa Rhea for their willingness to devote time and energy and agreeing to play a role in this work. The insight and recommendations that each of you added were invaluable. A debt of gratitude is owed to Heather Moore for helping me with data compilation and the statistical analyses – you are truly an expert in your field! I want to thank the Higher Education Administration faculty members that I was blessed to work and grow with at The Gadsden Center. The coursework was truly enjoyable. I miss the class meetings and will always cherish the memories we made. I thank each of my classmates whom I was so blessed to be able to spend the last three years of my life. More important than any title or degree that I earned are the lasting friendships that I made due to this experience. I must thank my friends and family that stood by my side and provided encouragement through each step of the journey. And most importantly I thank my Savior Jesus Christ for the ability to endure and the opportunity to take on this challenge. Many times over the last three years I prayed for clear thinking, a calm spirit to resist being overwhelmed, wisdom, and knowledge – not once was I denied. Thank you for wrapping me in your arms and keeping me throughout this season of my life.

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CHAPTER I:

INTRODUCTION

For centuries, higher education has served citizens by offering an opportunity for advancement – whether in a career, in the pursuit of learning for the sake of gaining knowledge, or in social status. As eager and energetic as a potential learner may be, there is a possibility that the student could reach the college level underprepared for a variety of reasons, which leads to the need for developmental work. In particular, the number of students that reach public two-year institutions in the nation that require and enroll in developmental classes continues to hover around 40% (National Center for Education Statistics [NCES], 2003; NCES, 2012c). Moreover, in the 2011 – 2012 school year, over 75% of public four-year and almost 100% of public two-year institutions reported offering remedial services (NCES, 2012b). Of the institutions that provide developmental education, few evaluations of remedial education exist, and those that are conducted are arguably useless due to both their lack of recommendations for how to improve and because they do not look at what these programs actually do (i.e., Grubb, 2001). Federal and state policymakers, students, administrators, teachers, and taxpayers are vested in higher education and are now seeing the task of improving developmental programs as a major priority (Bahr, 2010b; Cullinane & Treisman, 2010). It is important for program coordinators and administrators not only to understand the need for evaluating a program, but also to look at the right information. Time is a valuable resource and leaders benefit by ensuring that proper attention is given to evaluating success in a useful and efficient manner.

Since the inception of basic skills courses, which arguably date back to the early American colonial colleges of the 1600s (Breneman & Haarlow, 1998; Brubacher & Rudy, 2008; Keimig, 1983; Merisotis & Phipps, 2000), developmental programs have sought to do many things. Developmental classes are important because they provide students with the skills necessary to advance to the next level, and the United States economy depends on a population with at least minimal reading, writing, and math ability (Bahr, 2010b). Another explanation of these programs is that they provide underprepared students with not only subject-specific skills, but skills necessary to succeed in college and become gainfully employed in the labor market (Bettinger & Long, 2005). Furthermore, the programs offer a wide variety of services to students who wish to attend college but do not have the success skills needed – this includes study skills, time management skills, and other soft skills that accompany the subject-specific training (Le, Rogers, & Santos, 2011). Due to these pressing concerns, this study is introduced by taking a look at the widespread necessity, cost, and lack of data surrounding developmental education in the United States with a focus on two-year institutions.

Background to the Study

To provide background information for this study, the widespread necessity of developmental courses, the financial cost associated with providing these classes, and the lack of adequate evaluative data for developmental programs are presented in the sections that follow.

Widespread Necessity

As enrollment in higher education increases (which includes adults returning to the classroom), community colleges are seeing an increase in underprepared students (Le et al., 2011). In 2008, there were 1,045 community colleges enrolling 6.2 million students, which was over one-third of the enrollment for all institutions of higher education (Provasnik & Planty, 2008). At the time that this study was conducted, there were more than 1200 community colleges in the nation that serve nontraditional students (Osborn, 2013). Many of these nontraditional students require some type of remedial/developmental education. Mike Rose (in Osborn) responded to an interview question concerning the need for developmental education in college with respect to social mobility and second chances. He stated that, since we live in a society that is by nature unequal, there will always be a need for something that is available allowing those less fortunate a chance to move upward in life.

To highlight the lack of readiness that many students bring upon enrollment, the National Center for Research to Improve Postsecondary Teaching and Learning (NCRIPTAL) study conducted by Lattuca and Stark in 2009 reported the following: "about one-third of faculty in four-year institutions, compared to more than 60% of those in two-year institutions, said that 'most of the students I teach lack the basic skills for college level work'" (p. 148). With tuition on the rise and more restrictions on Pell grants, developmental education affects hundreds of thousands of students and their chances of having a postsecondary education (Nelson, 2011). Those that believe these programs are important are charged with the task of proving their worth and providing evidence to keep them going.

Looking deeper into this problem of skill deficiencies, Bahr (2007) found that the depth and breadth of need plays a role in student success. He referred to depth as the degree of deficiencies in a subject area. Breadth refers to the span, or number, of different areas of remediation required. In his work, there was a negative correlation between depth and breadth and chances for success. In other words, the more skills lacking and/or the more subject areas in which remediation is required, the less likely a student is to succeed. Since 75% of students that begin math remediation never reach the college-level course, there is much work to do in ensuring that postsecondary goals can be achieved by everyone that hopes to pursue this level of education (Bahr, 2007).

Cost

Developmental education is perhaps the most utilized and expensive program geared toward preparing students that are not ready for college-level work (Scott-Clayton & Rodriguez, 2012). The cost factors associated with developmental education include an increased cost due to hiring tutors with adequate credentials, faculty training, and implementation of student services and/or student programs for success and retention (Gallard, Albritton, & Morgan, 2010) – not to mention the added expense of instructor salaries to teach the classes and directors to run the programs. Despite the expenses, the investment in developmental education does more than pay for itself in the long run (Breneman & Haarlow, 1998).

Turning to another issue concerning cost, higher education leaders are surrounded by a decline in public opinion and cuts in public funding (Briggs, Stark, & Rowland-Poplawski, 2003). The problems facing higher education are heightened since there are so many financial reductions yet an increase in demand and accountability (Lueddeke, 1999). Some estimates show that a state's economy would see an extra $80 million if remedial courses in postsecondary institutions were eliminated, which includes over $50 million in direct expenses due to developmental programs and almost $30 million in lost earnings available if the students were to work instead of attend school (ACHE, 2011). In 2001, Saxon and Boylan estimated that around $1 billion was spent on developmental education in the United States on an annual basis. A more recent article reported that offering developmental courses has increased greatly and costs the nation anywhere between $1.4 billion and $2 billion annually (Denley, 2013). Therefore it is understandable that developmental education creeps onto the chopping block during budget meetings. Since public institutions are encouraged to educate all those who can benefit from higher education (Ignash, 1997), administrators and practitioners have the task of finding ways to not only keep developmental education, but also to improve its effectiveness in order to serve students.

Lack of Adequate Data

In general, higher education programs are mandated to conduct accurate evaluations due to accountability and funding issues (Weissman, Bulakowski, & Jumisco, 1997). Even though almost half of first-time college students require remediation each year, research on the issue of the effectiveness of these courses is scarce (Breneman & Haarlow, 1998; Calcagno & Long, 2009). Despite the large expenses involved and the continuous debate about whether and/or where to offer developmental courses, there is a large gap in the research concerning the effectiveness of these programs (Calcagno & Long, 2009). Compared to the number of institutions of higher education in the United States, only a small percentage that utilize developmental programs actually conduct systematic evaluation that continuously occurs each academic year (Boylan, Bliss, & Bonham, 1997; Collins, 2010). Some claim that the level at which developmental courses actually improve a student's success in college is unknown since strict evaluation designs are not being conducted that look at follow-up items such as persistence, success in subsequent courses, and college grade point average (Levin & Calcagno, 2008). Furthermore, the only way to reach this standard is through rigorous evaluation of the effectiveness of developmental programs (Levin & Calcagno, 2008).

Oddly enough, most colleges in the nation do not even evaluate their developmental programs (Bahr, 2008b; Grubb, 2001). Boylan and Saxon (2010) have asserted that "there is little evidence that state higher education policies affecting tens of thousands of students, for instance, are systematically based on ‘gold standard’ research,” with the gold standard being large scale experimental studies with “random assignment of subjects and control groups” (p. 36). Although many large-scale studies have been conducted, there are no control groups used for comparison (Boylan & Saxon, 2010). Data on the effectiveness of remedial programs has not been fluid, has not been adequately funded, and has not been comprehensive or complete (Merisotis & Phipps, 2000).

More specifically, many institutions are faced with the issue of finding the most effective way to evaluate developmental mathematics. Smith (1983) discussed the various ways that many programs choose to evaluate their developmental mathematics courses. Although she acknowledged that using formative and summative program evaluations is beneficial, this tool is lacking. She went on to state that single-group pre-test/post-test comparisons, which she found were used most often at that time, are susceptible to biases.

Problem Statement

The problem addressed in this study came about due to concerns over many issues regarding colleges offering developmental education in the United States. The need for these no-credit courses is growing due to the number of underprepared students entering higher education. The cost of offering these courses puts a strain on budgets that are already stretched thin. Once the developmental programs are in place, effectively evaluating their success is both inconsistent and intermittent throughout colleges in the nation.

Many scholars believe that developmental education has been around since the inception of higher education (Breneman & Haarlow, 1998; Brubacher & Rudy, 2008; Keimig, 1983; Merisotis & Phipps, 2000). Centuries later, the Morrill Land Grant Acts, the GI Bill, the Higher Education Act of 1965, and many other important events in history continued opening the doors of higher education to virtually anyone interested. In 2009, President Barack Obama sparked the initiative to challenge every American to complete at least one year of college or career training (Obama, 2009). Thus, citizens are encouraged now more than ever to enter higher education.

The historic events stated above have helped to create a well-trained citizenry as well as aided in increasing the odds of achieving the "America dream" since many college students come away more with workplace skills and greater chances of social mobility (Brenneman et al., 2010; Obama, 2009). Although these benefits are rewarding, challenges follow. With open access comes the possibility of more students entering college underprepared. This leaves many scholars divided concerning whether preparatory courses belong in higher education. Some suggest that the courses simply do not belong in postsecondary work (for example, see McCabe & Day, 1998). Others have argued that such courses act as more of a barrier rather than a bridge (Bonham & Boylan, 2011; ACHE, 2011; Kolajo, 2010; Bahr, 2013; Cullinane & Treisman, 2010; Bahr, 2012; Crisp & Nora, 2012; Hoyt, 1999; Deil-Amen and Rosenbaum, 2002; Adelman, 2004a; Glenn & Wagner, 2006; Attewell, Lavin, Domina, & Levey, 2006). A third argument is that potential earnings are lost and students do not earn credit while still paying full tuition (Calcagno & Long, 2009). Another position taken has been that taxpayers should not have to pay for the same instruction twice (Bahr, 2008b, 2010; Blanchette, 1997; McCabe & Day, 1998; Hebel, 1999; Phipps, 1999; Adelman, 1996). Similarly, it is argued that developmental programs drain resources from other areas of the institution (Moss & Yeaton, 2006). Finally, several people opposed to developmental education submit opinions stating that such courses lower the standards of a college degree (Astin, 1998; MacDonald, 1997, 1998, 1999; Bahr, 2008b; Merisotis & Phipps, 2000; Moss & Yeaton, 2006). Thus many join ranks and affirm that developmental education should not be included in the college curriculum.

Those on the other side of the fence voice strongly that developmental education has its worth at the college level. To begin, scholars that support offering this type of instruction find that they help create a more educated citizenry (Altbach, Gumport, & Berdahl, 2011; Rose, 2009). Further, the courses provide opportunity when it comes to concerns over access issues (Howell, 2011; Lavin & Weininger, 1998; NCES, 2012b). In addition, they contribute to a more skilled workforce (Bahr, 2010b; Brenneman et al., 2010; Gallard et al., 2010). Finally, they act as bridges to college level work as opposed to a barrier (Attewell et al., 2006; Bettinger & Long, 2005, 2009; Howard & Whitaker, 2011; Kolajo, 2010; Lesik, 2007; Zavarella & Ignash, 2009;).

Despite the resounding voices of disdain and support for developmental education at the college level, many institutions continue to offer these classes. Depending on the institutional type, anywhere from 67% (public and private 4-year) to almost 100% (public and private 2-year) of American colleges and universities offered remedial services during the 2011-2012 academic year (NCES, 2012b). Moreover, there were more than 2.8 million students that required remediation in this country during that time period (NCES, 2012c).

In addition to the problems surrounding the necessity of offering developmental education are the issues of evaluation and accountability. With pressures rising from both internal and external stakeholders, researchers and practitioners are stressing the importance of adequate research design (for example, see Moss & Yeaton, 2006) and accurate program evaluation (for instance, see Kolajo, 2010). In the past, evidence has been scarce (Bahr, 2010b; Bettinger & Long, 2005, 2009; Boylan, Bonham, & Bliss, 1997; Collins, 2010) if gathered at all (Grubb, 2001). Adequate information gathered arguably includes skills test scores as well as persistence and completion data (Bahr, 2008b; Collins, 2010). Additionally, tracking progression and performance in the college-level course is vital to achieve effective evaluation of developmental programs (Bailey, 2010).

In summary, there is a high cost associated with decisions made concerning developmental education. This cost is regarding the actual price tag, but also the future for this country and the livelihood of its citizens. The fact that these courses have perhaps been offered since American colleges began does not guarantee that they will continue to hold a place in higher education. More and more students are entering college, and the knowledge gap seems to continually widen. Accountability issues charge administrators, practitioners, and researchers to not only gather data to determine the worth of these courses, but to be sure to gather the right data and analyze it in a meaningful manner.

Purpose of the Study

As explored above, it is clear that standards are needed to ensure that developmental education is evaluated in a meaningful way. Through the centuries until now, multitudes of underprepared students have enrolled in higher education. Institutions of higher learning are charged with the task of collecting and analyzing data on the effectiveness of all of its programs, including remedial services when offered (Dickeson, 2010; Lattuca & Stark, 2009; Nichols & Nichols, 2005). Those involved have a call to analyze these statistics effectively (Bahr, 2010b; Bettinger & Long, 2005, 2009; Boylan, Bonham, & Bliss, 1997; Collins, 2010; Grubb, 2001; Kolajo, 2010; Moss & Yeaton, 2006).

Focusing on developmental mathematics in particular, there are many opinions on *how* to effectively evaluate these programs. Several variables can be utilized. Looking at the passing rate in the first college-level math class (Bailey et al., 2010; Boggs, 1997; Collins, 2010; Gerlaugh, Thompson, Boylan, & Davis, 2007; Merisotic & Phipps, 2000; Nichols & Nichols, 2005), persistence in college (Boggs, 1997; Collins; 2010; Grubb, 2001; Nichols & Nichols, 2005), college grade point average (Boggsm 1997; Mersotis & Phipps, 2000), and college graduation rates (Boggs, 1997; Collins, 2010; Merisotis & Phipps, 2000) offers a template for evaluating the effectiveness of a developmental program.

Furthermore, a closer analysis of student demographics can provide feedback and spark innovation when changes need to be made to the developmental programs. Student characteristics such as gender, age, race, and test scores are useful when analyzing these programs. Researchers differ when it comes to the adage that males perform better in math than females, and studies conducted show this disparity (Cooper & Robinson, 1989; Gunderson, Ramirez, Levine, & Beilock, 2012; Penny & White, 1998; Porter & Edgar, 1987; Rawley, 2007; Rech, 1996; Spradlin & Ackerman, 2010; Walker & Plata, 2000). Researchers also note the performance differences concerning age (Penny & White, 1998; Walker & Plata, 2000; Wolfle, 2012). This is important because strategies can be implemented to reach both traditional and non-traditional learners. Many scholars see a difference in outcomes when it comes to a student's race/ethnicity (Bailey et al., 2010; Goldstein, Burke, Getz, & Kennedy, 2011; Penny & White, 1998; Walker & Plata, 2000; Wolfle, 2012). And looking at test scores in the subject area (Grubb, 2001; Weissman et al., 1997) gives an idea as to the background knowledge that a student brought to college and the knowledge gap that was hopefully closed after completing the developmental training.

Given the important issues from specialists that were noted above, there is a standard that needs to be followed in terms of evaluating the effectiveness of developmental programs. The purpose of this study is to conduct an analysis on the effectiveness of the developmental mathematics program at a community college in the Alabama Community College System. This investigation looks at whether the remediated students performed as well as the exempted students in the first college-level math course and compares these groups based on college graduation status, college grade point average, continuous enrollment in college, and ACT/COMPASS math subtest scores. COMPASS is the placement-testing component utilized by the community college in this study. Additional variables tested were age, gender, and race. Boggs (1997) utilized this research design in his work. This study updates the literature and uses an adaptation of his method along with the scholarly recommendations listed above as a guide for structuring the analysis.

Significance of the Study

Researchers are calling for and colleges are searching for an effective way to determine whether change is needed in their developmental programs. The work conducted here attempts to present a method of evaluation to the participating institution that will bring fluidity to developmental program evaluation. Since many institutions are tracking the wrong data (Bailey, 2009; Boylan & Saxon, 2010; Koski & Levin, 1998), it follows that the development of a uniform, acceptable way to evaluate developmental programs is needed. Multiple experts agree that there needs to be a systematic way to collect and measure outcomes (Bahr, 2008b; Bettinger & Long, 2009; Boylan, Bonham, & Bliss, 1997; Collins, 2010; Grubb, 2001) that gives more meaning to the word "effective." This study attempts to lay the foundation for that systematic method of evaluation for the participating institution. Other institutions of higher education might be interested in utilizing the research design in order to determine the effectiveness of their developmental programs.

Additionally, this study adds to the literature on effective evaluation of developmental programs. Many students have benefited from developmental mathematics and have achieved goals of a higher education. These attainments would not have been possible had the opportunities for these basic skills classes not been available. The participating institution can determine the effectiveness of developmental mathematics courses in their attempts to contribute to the success of underprepared college students by using systematic evaluation as shown in this study.

The research conducted seeks to add another element to the literature concerning academic performance due to student demographics. As described earlier, there is some discrepancy among generalizations based on gender when it comes to placement in and success in developmental mathematics. This study provides additional analyses based on male and female performance. Furthermore, since instructional strategies are being pushed with respect to educating the adult learner returning to school as well as the traditional age student, this work looks at age and provides more information to this portion of research that continues to grow. Similarly, research shows that non-White students tend to be overrepresented in developmental mathematics and have a lower success rate in those courses (Bailey et al., 2010; Goldsein, Burke, Getz, & Kennedy, 2011; Penny & White, 1998; Walker & Plata, 2000; Wolfle, 2012). Along with answering research questions as a whole group, the work at hand aggregates the data based on race and provides an added component to the literature in this area.

Since some researchers claim that comparing only passing rates in the college-level course for developmental and non-developmental students is flawed due to the fact that these groups have inherent differences and therefore cannot be compared (Bettinger & Long, 2005; Levin & Calcagno, 2008), this study further sorts the data by ACT/COMPASS math subtest scores. Indeed those that are placed in developmental classes lack the skills necessary to begin college level work. But if developmental classes do what they are designed to do, these students will leave the preparatory classes with the knowledge base needed to succeed in the college work. Thus by reporting ACT/COMPASS math subtest scores, this study shows whether the developmental students really overcame a gap in knowledge and were able to pass the first college-level course.

The Director of Institutional Effectiveness and the Division Chair of the Mathematics Department at the participating institution can utilize the results of this study to determine whether the developmental classes are meeting their goals and whether they need to undergo changes. This study consists of comparing the pass/fail status of the developmental students to the non-developmental students in the first college-level mathematics course and will provide all information to the participating institution.

Objectives and Outcomes

The specific objective of this dissertation is to produce the following outcomes: (1) determining the developmental status and student characteristics that contribute to academic success at the participating institution, (2) data for the participating institution's mathematics department to utilize in measuring the effectiveness of its current practices, (3) data for the participating institution's research department to utilize in measuring the effectiveness of the program in order to make decisions, and (4) contribution to the literature on how developmental and non-developmental students perform based on age, gender, and race.

Definition of Terms

Andragogy. Learning strategies for the adult learner.

College grade point average (GPA). College GPA was defined as the college grade point average. The participating institution was on the semester system and used a four-point grading system, with final letter grade assignments having the following quality point values: A = 4, B =

3, C = 2, D = 1, F = 0. Grade point average was computed by computing the number of quality points earned during the semester (grade points multiplied by the credit hours). The total quality points was then divided by the total number of credit hours attempted.

Continuous enrollment. Continuous enrollment was defined as the total number of semesters that a student enrolled at the participating institution at the time of data collection. No weight was given to the number of hours taken per semester.

Credit-level mathematics (or college-level mathematics). Credit-level mathematics and college-level mathematics were both defined as the mathematics course entitled MTH 100-Intermediate Algebra at the participating institution. This was the first credit-level mathematics course available to students at this community college.

Developmental. Developmental was defined as not meeting standards for a college course. Debates are ongoing concerning the titles “developmental” and “remedial,” and various terms are used to describe those not ready for college-level work, such as underprepared, basic skills, remedial, developmental, or interchangeably as remedial/developmental. Some distinguish between developmental and remedial by labeling developmental as teaching not only content in the subject area, but success skills as well (Moss & Yeaton, 2006). The terms “developmental” and “remedial” were considered as synonyms in this study.

Developmental math students. Developmental math students were defined as students who scored below 36 on the algebra portion of the COMPASS exam (the participating institution’s placement entrance exam) or scored below 20 on the math portion of the ACT-test. Developmental math students were considered underprepared in math. If they started in MTH 090 – Basic Mathematics, then they were required to score a C (75 – 79) or better in the course and were required to pass a departmental final exam to proceed to MTH 098 – Beginning

Algebra. For those that tested in MTH 098, they were required to score a C (75 – 79) or better in the course and were required to pass a departmental final exam to proceed to MTH 100 – Intermediate Algebra.

ENG 101. ENG 101 (English Composition I) is the first college-level English course at the participating institution.

Failing. Students were coded as "failing" if a "D," "F," or "W" were earned in MTH 100, such that a D = 60 – 69 and an F = 59 and below.

Graduation. Graduation was achieved when a student met the requirements of the participating school system for a two-year Associate of Arts Degree, a two-year Associate of Science Degree, a two-year Associate of Applied Science Degree, a Certificate, or a Short-Term Certificate at the participating institution.

Graduation status. A student was coded as "graduated" if a degree or certificate was earned during the study period from fall 2002 to summer 2013.

MTH 100. MTH 100 (Intermediate College Algebra) is the first college-level mathematics course at the participating institution, which is an intermediate algebra course with the following objectives:

1. Demonstrate the ability to perform operations with rational functions.
2. Demonstrate competent skills in graphing linear functions.
3. Demonstrate the ability to write a linear equation.
4. Demonstrate competent skills in functions by exhibiting the ability to evaluate a function
5. Demonstrate the ability to solve a linear system of 2 equations with 2 unknowns
6. Demonstrate the ability to graph a linear inequality in 2 variables
7. Demonstrate the ability to perform basic operations with radicals

8. Demonstrate the ability to perform basic operations with complex numbers.

9. Demonstrate the ability to solve a quadratic equation

10. Demonstrate the ability to graph a quadratic equation.

MTH 100 students. MTH 100 students were defined as students who took MTH 100 during the 10-year period beginning fall semester 2002 and ending summer semester 2012.

MTH 116. MTH 116 (Basic Mathematics with Applications) is considered a college-level course at the participating institution and is the accepted math course for some of the technical and two-year degree programs with the following objectives:

1. Demonstrate the ability to solve problems involving ratios.
2. Demonstrate the ability to solve problems involving proportions.
3. Demonstrate the ability to solve problems involving percents.
4. Demonstrate the ability to solve problems involving simple interest.
5. Demonstrate the ability to convert units within the metric system of measurement.
6. Demonstrate the ability to calculate the probability of simple events.
7. Demonstrate the ability to perform basic operations on integers.
8. Demonstrate the ability to solve a linear equation.
9. Demonstrate the ability to solve problems involving linear equations.

Non-developmental math students. Non-developmental math students were defined as those students who scored in the range of 20 – 22 on the ACT math subtest or 36 or higher on the algebra portion of the COMPASS math subtest placement exam. These students were not considered underprepared in mathematics and were not required to enroll in pre-college math courses.

Passing. Passing was defined as a grade of "A," "B," or "C," where A = 90 – 100, B = 80 – 89, and C = 70 – 79 for college-level math courses.

Pass/fail status. A student was coded as "passing" MTH 100 if an "A," "B," or "C" was earned. Scores of "D," "F," and "W" were coded as "failing."

Remedial. Developmental was defined as not meeting standards for a college course. Debates are ongoing concerning the titles "developmental" and "remedial," and various terms are used to describe those not ready for college-level work, such as underprepared, basic skills, remedial, developmental, or interchangeably as remedial/developmental. Some distinguish between developmental and remedial by labeling developmental as teaching not only content in the subject area, but success skills as well (Moss & Yeaton, 2006). The terms "developmental" and "remedial" were considered as synonyms in this study.

SME Club. Science, Math, and Engineering Club (at participating institution)

STEM field. A course in a science, technology, engineering, or mathematics discipline.

Conclusion

This dissertation is divided into five chapters. The opening chapter introduced the background to the study, the problem statement, the purpose of the study, the significance of the study, and the objectives and outcomes. Chapter II reviewed the related literature that outlines scholarly work in the history of developmental education, the widespread necessity of developmental education (including colleges offering this type of program, voices of opposition and support, students needing these basic skills courses, and a look at demographic issues, all with a focus on developmental math), and evaluating developmental programs. Chapter III presents the methodology for this study. Results obtained from this research were stated in

Chapter IV. Chapter V discussed the findings and provided implications of these results as well as suggestions for future research.

CHAPTER II:

REVIEW OF LITERATURE

The role of developmental education at the postsecondary level has been scrutinized by many and stirs up controversy from a variety of angles (Moss & Yeaton, 2006). To address some issues at hand, this chapter begins with a review of the literature concerning the history of developmental courses at the postsecondary level. Second, a look at the widespread necessity of developmental programs is presented. This is accomplished by examining the literature surrounding colleges offering developmental programs and providing the opposing and supporting views of offering developmental courses at the college level. Then the students needing developmental classes will be presented along with the literature related to demographic variables such as gender, age, and race, all with a focus on developmental mathematics. Finally, a review of the literature addressing how to effectively evaluate developmental programs will conclude the chapter. The purpose of the review is to lay the foundation of work conducted by previous scholars in the areas pertaining to this study, as well as providing a sound basis for the choice of research design to be conducted.

History of Developmental Instruction

The use of developmental education in American postsecondary institutions can be traced as far back as 1630 when students aspiring to enter American colonial colleges hired private tutors to gain proficiency in Latin (Breneman & Haarlow, 1998; Ignash, 1997; Merisotis & Phipps, 2000). Keimig (1983) found that under-preparedness dates as far back as the 1600s, when Harvard educators had to grant admission to college students that did not meet their standards. Brubacher and Rudy (2008) posited that the only way to gain skills necessary to begin studying at the college level was either by private tutor or with the help of a minister. Many prospective Yale students would live with a minister to undergo a type of apprenticeship in which the student would learn the skills needed to begin college work at the institution (Brubacher & Rudy, 2008). They also stated that some colleges offered an alternative set of courses that led to a different degree if skills were lacking, but this was not a popular option.

Continuing into the mid-18th century, land grant colleges made use of a preparatory department for below-average students in the areas of reading, math, and writing (Merisotis & Phipps, 2000). Some states chose to place a heavy focus on elementary education, which left the high school initiatives with much to be desired (Brubacher & Rudy, 2008). In turn, a large gap formed in student skills between high school and college. To close this gap, colleges formed departments with the aim of bringing students up to speed on the skills needed for college level work (Brubacher & Rudy, 2008). The University of Wisconsin was the first institution that added remedial education as a program in 1849, which included reading, mathematics, and writing (Breneman & Haarlow, 1998). This was unpopular with many critics who believed that college credit should not be given for work at the high school level. However, in 1915, there were 350 higher education institutions that reported utilizing these preparatory programs (Brubacher & Rudy, 2008).

With the University of Wisconsin taking the lead, many systems of higher education began to offer these programs throughout the 19th century. By the 1900s, junior colleges began to take over the enrollment for developmental education. As a result of veterans returning to the country after World War II, the GI Bill brought in more need for remedial education. Later, the Higher Education Act of 1965 and its open admissions policies added to enrollment in these programs. Breneman and Haarlow (1998) stated that, in the 1980s, around 30% of entering students needed remediation after governmental regulations mandated placement testing for entry into college classes. The majority of institutions that offer these classes today do not allow the hours to count for college credit – this was not always the case in the history of preparatory classes (Breneman & Haarlow, 1998).

Although some feel that the responsibility of developmental education should rest solely on the shoulders of community colleges (Breneman & Haarlow, 1998; McCabe & Day, 1998), these programs still exist in four-year institutions today. Merisotis and Phipps (2000) asserted that "remediation is not an appendage with little connection to the mission of the institution but represents a core fit of the higher education community that it has performed for hundreds of years" (p. 79). Therefore decisions being made to cut training programs altogether are quite controversial. Disagreements abound concerning the type of institution that should offer developmental classes. Despite the pressures to rid four-year institutions of preparatory courses, some believe that these courses belong at both types of institutions with community colleges playing a larger role (Ignash, 1997). Recently, many states have made major changes to what once was common in higher education. Instead of allowing students to take developmental classes in college, institutions are changing the rules. Some states have removed developmental programs from college altogether (Kolajo, 2010; Lively, 1993), or at least restricted them only to the community colleges (Bettinger & Long, 2005; Kolajo, 2010). This poses a problem for two-year institutions in terms of offering these services to an increasing number of students while concurrently being faced with budget cuts (Kolajo, 2010). In fact, California recommends that students complete their preparatory work at a community college before taking a course at any of the four-year institutions (Bettinger & Long, 2005). Arizona, Florida, Montana, South Carolina, and Virginia actually prohibit any four-year university from offering developmental programs (Bettinger & Long, 2005).

Many scholars are in agreement that remediation has been around since the beginning of American higher education (Breneman & Haarlow, 1998; Brubacher & Rudy, 2008; Ignash, 1997; Keimig, 1983; Merisotis & Phipps, 2000). But not all are in favor of colleges adopting these programs (Bahr, 2008b; Bettinger & Long, 2009; Bonham & Boylan, 2011; Ikenberry, 1999; MacDonald, 1997, 1998, 1999; McCabe & Day, 1998; Merisotis & Phipps, 2000; Yeaton, 2006). An institution can look at its mission and determine whether serving the developmental population is something that the college can or wants to withstand.

Widespread Necessity of Developmental Education

Developmental education has quite an extensive history, as noted above. The section that follows delivers a description of how these programs appear today. First, a look at the colleges offering a developmental program is presented, followed by the voices of opposition and support concerning remedial classes on college campuses. Second, a picture of the students needing remediation (particularly in mathematics) is outlined, along with a look at the literature concerning characteristics such as gender, age, and race.

Colleges Offering Developmental Education

There are two sides to every coin. As with many issues in higher education, there are both advantages and disadvantages of choosing to offer preparatory courses. Due in part to the costs associated with offering developmental education, critics often push for these programs to be eliminated (Adelman, 1996; Bahr, 2008b, 2010; Blanchette, 1997; Hebel, 1999; McCabe & Day, 1998; Phipps, 1999). The following sections address the issues opposing and supporting developmental programs in higher education and conclude with the data available on the number of colleges that offer these basic skills courses.

Voices of opposition. Disagreement abounds when it comes to the topic of higher education institutions offering developmental education to their undergraduates. The concerns presented here consist of the following arguments: the courses are inappropriate at the college level, the courses carry a negative financial impact, the courses are a source of belittlement, and there is no proof that the courses even prepare students for college work.

McCabe and Day (1998) claimed that these courses have no business in the realms of postsecondary work. Bonham and Boylan (2011) affirmed that courses on the developmental level act as more of a barrier as opposed to a benefit to most of the students enrolled in these classes. Potential earnings are lost while students take these classes and, although they do not earn college credit, students still pay full tuition (Calcagno & Long, 2009).

A second voice in opposition comes from the financial side. This camp claims that taxpayers should not have to pay for students to take the same courses twice, once in high school and again in college (Adelman, 1996; Bahr, 2008b, 2010a; Blanchette, 1997; Hebel, 1999; Phipps, 1999; McCabe & Day, 1998). Gregory Fitch, the executive director of the Alabama Commission on Higher Education, has claimed that developmental programs cost both the state and the student's money yet do not lead to desired results (ACHE, 2011).

In turn, if money is being spent on developmental programs that teach to objectives that should have been learned in high school, then these programs drain resources from other areas of the institution (Moss & Yeaton, 2006). Taxpayers and policymakers do not want to pay for the same objectives at both levels of learning, and students want to cut down on both the expense of a college degree and the time it takes to complete the requirements for a degree (Howell, 2011), both of which are affected by developmental education.

On top of draining resources, these classes serve a role of belittlement to faculty, alumni, and students. The faculty that are charged with teaching these pre-college courses are at risk of being marginalized by their colleagues and/or peers (Bahr, 2008a) due to the symbolic image of being ”sent down” to such a low level to teach.

Another aspect of how developmental education at the college level serves a diminishing role is concerning the alumni. Many times there is a sense of pride and prestige associated with holding a higher degree. Anything that contributes to a reduction in the value of that achievement potentially draws opposition. One side of this opposition is the belief that offering developmental training in college negatively affects the reputation of earning a higher degree since the presence of these classes are believed to water down the value of a college degree (Astin, 1998). Since remedial classes are geared toward students that are not ready for college-level work, allowing developmental education lowers the quality of a college degree (Bahr, 2008b; MacDonald, 1997, 1998, 1999; Merisotis & Phipps, 2000). Moss and Yeaton (2006) even claimed that offering these basic skills courses at the college level will, sooner or later, lower the academic standards of higher education. Disdain at the student level occurs since there are emotions of inadequacy, embarrassment, and/or fear at being placed in these courses that require much work but are not even at a level to earn college credit (Walker & Plata, 2000).

Some see developmental education as belittling by reaching all the way back to secondary school. If students not ready for college can enroll in these classes to catch up on skills, then that provides a free ticket for students to be slackers in high school (Bettinger & Long, 2009). Some blame the problem on high schools and claim that the widespread necessity of developmental education reveals a decline in the level of preparation of students in their pre-college work (Altbach et al., 2011; Ikenberry, 1999; Le et al., 2011).

Along with the negative aspects listed above, opponents claim that there is no evidence stating that the courses do what they promise to do. Some say that enrolling in developmental courses increases the time to degree and possibly discourages students from completing a program since the work does not bear any credit (ACHE, 2011; Kolajo, 2010). In Kolajo's work, developmental students took an average of eleven semesters to graduate as opposed to those that did not require remediation completing in only eight terms. In fact, Gregory Fitch, the executive director of the Alabama Commission on Higher Education (ACHE), posits that developmental education makes students less likely to finish college and become productive workers since many that enroll in these classes do not complete college (ACHE).

With mathematics, in particular, very few students complete the developmental sequence and go on to achieve proficiency in college-level math (Bahr, 2013; Cullinane & Treisman, 2010). Bahr collected data from first-time freshmen enrolled in the California Community College system in the 1995 cohort. For students with deficiencies in math or English, 20% did not achieve college competency in math or English, 38% achieved college competency in one or the other, and 42% achieved college competency in both. For students with deficiencies in both math and English, 58% did not achieve college competency in math or English, 23% achieved college competency in one or the other, and 19% achieved college competency in both math and English. Cullinane and Treisman found that around two-thirds of students that were either recommended or required to take a developmental mathematics sequence in a community college did not complete the courses. Thus some argue that developmental courses are not helping students reach their goals, so they should not be offered in higher education.

To magnify our understanding of this problem, Bahr (2012) found that the lower a student started in the developmental sequence, the less likely that college-level skills were attained. To understand why students were leaving during the remedial sequence, Bahr implemented a system of optimal, semi-optimal, and suboptimal scenarios in his research. Each situation looked at students attending at least nine semesters and enrolling in at least 10 hours per semester. The optimal and semi-optimal scenarios meant that students passed the remedial courses on the first attempt and there was either no delay in math courses taken or a delay of at least one semester, respectively. The suboptimal scenario meant that students failed to pass each subsequent course and had at least one semester delay between enrolling in the next level. Students who started at the arithmetic or pre-algebra level passed the college-level course on the first attempt at rates ranging from five to twelve percentage points less than those that started higher in the sequence. Additionally, when a student did not pass a developmental course, progressing on and passing the subsequent courses was not as likely as those that passed on the first attempt. Even when progressing at the optimal level, students starting at the arithmetic level had a 93% chance of making it to pre-algebra, a 90% chance of making it to beginning algebra, and an 83% chance of making it to intermediate algebra. So, even in the best of circumstances, the chances of attempting each subsequent course saw a continual decline. This might lead one to wonder if the classes are worth it.

Crisp and Nora (2010) found in their *t*-test analysis that non-developmental students in their observation group had a higher GPA in the first year of college than those students that took developmental classes ($t(570) = 2.563$, $p < .05$). Hoyt (1999) conducted a study on remedial education and student attrition. This work yielded a positive correlation between the number of developmental areas and dropout rates. In other words, the more subject areas in which a student needed remediation, the more likely the student was to drop out of college. His study found that between 64% and 72% of the students that required remediation in all three areas (English, reading, and mathematics) eventually dropped out of college. Deil-Amen and Rosenbaum (2002) claimed that, since remedial education extends the time to degree by at least three semesters (for those students that begin at the lowest level), then this delay in taking non-credit courses potentially contributes to college dropouts.

Some researchers found that students who took developmental classes in college had lower graduation rates than non-developmental students (Adelman, 2004a; Glenn & Wagner, 2006). In Adelman's cohort of study, 58% of the students requiring at least one or two remedial math courses did not earn a credential and 59.3% of the students requiring at least one remedial math course and at least one remedial English or reading course did not earn a credential. This is in comparison to 31.2% of students that did not require remediation and did not earn a credential. In Bahr's 2007 work on the depth and breadth of developmental needs stated earlier, the lower a student begins in a developmental sequence and the more areas of deficiency imply lower chances of success. He found that students that required basic arithmetic and at least one other remedial class had an average of 2.15% chance of being successfully remediated to the college level. Average probabilities of reaching college-level readiness for students that required at least one remedial course and pre-algebra saw a 3.3% chance, beginning algebra an 8.25% chance, and intermediate algebra a 23.35% chance. Because of this, some see developmental education as creating a false belief for academically weak students to think they can succeed (Attewell et al., 2006).

On top of lower grade point averages and lower graduation rates, the more developmental courses a student takes, the longer it takes to graduate (Kolajo, 2010). From Kolajo's study, the students that required at least two developmental classes, who had an average age at graduation of twenty-seven years, took the longest to graduate (eleven semesters) and had the lowest GPA (2.86 overall) compared to those that had one or no developmental course(s). Cullinane and Treisman (2010) conducted a study concerning success in developmental mathematics at the community college level. They found that earning either near-perfect or perfect scores in the developmental mathematics sequence did not ensure success in the college-level course. In fact, they saw that less than half of the students that scored these perfect or nearly perfect marks actually completed the math course that counted toward college credit.

Many that pull for developmental education at the college level do so for reasons of equality and access (Altbach et al., 2011; Lavin & Weininger, 1998; Rose, 2009). The issue is that, without developmental education, these underprepared and underrepresented students are confined to their status without an escape. Although Bahr (2010a) acknowledged that this is the intent of higher education (to offer both disadvantaged and advantaged groups the benefits of learning skills needed at the college level), he found that developmental education did not assist in reaching that goal. In his study on the racial inequalities in developmental mathematics, the success rates differed significantly according to one's race. For instance, White students were 3.1 times more likely to be remediated successfully compared to Black students and were 1.6 times more likely to be successfully remediated than Hispanic students.

To highlight the extent of opposition that exists toward developmental education in higher education, the following quotes provide concerns that scholars have made public about the topic:

1. “Developmental education has become not an entryway but a burial ground for the aspirations of myriad community college students seeking to improve their lives through education” (Cullinane & Treisman, 2010, p. 2);
2. “Too many students find developmental mathematics to be an insurmountable impediment to their academic success” (Merseth, 2011, p. 37);
3. “If we fail to develop more effective means for educating ‘remedial’ students, we will find it difficult to make much headway in resolving some of our most pressing social and economic problems – unemployment, crime, welfare, health care, racial tensions, the maldistribution of wealth, and citizen disengagement from the political process” (Astin, 1998, para. 6);
4. “Developmental mathematics courses represent the graveyard of dreams and aspirations” (Merseth, 2011, p. 32); and
5. “The challenge, as we see it, is to redesign the developmental education system so that it is a powerful engine of upward mobility for the great majority of students whose economic futures depend in significant part on its effectiveness” (Cullinane & Treisman, 2010, p. 4).

Given these quotes by scholars in the field, it is evident that issues abound when it comes to developmental courses at the postsecondary level.

Voices of support. Moving to the other end of the spectrum, many scholars firmly believe that developmental education serves an important place in higher education. This section looks at how developmental classes are appropriate and actually set a standard for a degree, meet access needs, fulfill economic needs, and are proven to work.

A critique addressed earlier was that developmental courses have no business in the college classroom and that these classes are watering down the meaning of a college degree (Bahr, 2008b; MacDonald, 1997, 1998, 1999; McCabe & Day, 1998; Merisotis & Phipps, 2000). Attewell, Lavin, Domina, and Levey (2006) refuted this claim from the camps opposed to developmental programs. They pointed out that many public institutions require students to take remedial coursework depending on scores from standardized tests and/or basic skills tests at the institution. However, from their study, they found that private institutions did this at a lower frequency when compared to academically similar students. This proved to the group that offering developmental courses did not, in fact, lower the quality of higher education – in fact, it did the opposite. Institutions that require developmental courses set a basic skills standard in postsecondary education. Thus remedial programs serve two functions, according to Attewell, Lavin, Domina, and Levey (2006); first, they are a second-chance policy, and second, they serve the role of institutional quality control.

Supporters believe that providing developmental programs fulfills the open door policy offered by many institutions. Without these programs, many groups are left underserved. The seasoned adult returning to school hoping to change careers might need remediation when it comes to academic skills. The displaced worker that needs to earn a degree and subsequently become more marketable may need skills that were missed out on in high school. The low-income, first-generation student that was trained at a low-performing school never gained a meaningful understanding of many subject-specific objectives. The special needs student that needs the extra time and attention to master each skill benefits from developmental courses. Even the regular education student that is apprehensive about college can benefit when s/he chooses to take a lower-level course to gain confidence and work toward a better chance of succeeding in college-level classes. Doing away with developmental programs in postsecondary education potentially leaves earning a degree only for the privileged. All of the groups mentioned above would no longer have a chance to achieve this dream.

Additionally, developmental programs contribute to access issues since statistics show that many students of color, students that are first-time degree seekers, students from less wealthy families, and English as a second language (ESL) students need remediation (NCES, 2012b). A study conducted by Crisp and Nora (2010) looked at the impact that developmental courses had on the persistence and transfer of Hispanic community college students. From their Chi-square analysis, it was determined that the first-year developmental students they observed were more likely to persist in the subsequent year when compared to students that did not need developmental classes ($\chi^2(1, 570) = 6.500$, $p < .05$). They also found that students in their observation group that enrolled in developmental classes were over one and one-half times as likely to experience academic success as opposed to those that did not take developmental classes. Developmental courses in college serve a purpose of possibly catching underrepresented students that are at risk of falling through the cracks of the system (Howell, 2011).

Next, since the U.S. economy requires a skilled workforce (Bahr, 2010b), the students left out of higher education due to a lack of educational skills are, in turn, potentially left out of jobs. By meeting the mission of open door access, colleges are enhancing the nation's citizenry by giving everyone the opportunity to earn a degree (Altbach et al., 2011). Rose (2009) stated that "remedial programs are necessary if we want to educate a wide sweep of our citizenry. […] And, if we are wise enough to see, they can be a source of valuable information" (p. 4).

Another aspect of support from the economic side is that developmental education is important for enhancing our nation. Those seeking postsecondary work will be trained with necessary skills to hopefully advance to the next level, whether it be in terms of the next degree, a promotion, increasing job skills, or even learning for the pursuit of knowledge. Hence developmental education is important since the economy of the United States depends on a population with at least minimal reading, writing, and math ability (Bahr, 2010b). Some say that to maintain a vibrant democracy and to enhance our nation's ability to compete globally, our education and policy leaders must be proactive (Brenneman et al., 2010). Never before have so many job descriptions required high levels of degree attainment, and leaders in education play a vital role in the impact that the higher education opportunity has on social mobility (Brenneman et al.). President Barack Obama (2009) posited that the only way for people to move to the middle class is through higher education. But the concern does not stop with enrollment – the benefits of student retention are increased revenues for colleges, state reimbursements, and economic impacts such as better health, higher earnings, and reduced crime rates (Gallard et al., 2010).

Providing developmental education serves an important role of developing a well-educated citizenry. In a study conducted by Attewell, Domina, and Levey (2006), students from families in the lowest socioeconomic status made up 52% of the subjects that required remediation. Yet they were not the only ones that took developmental classes. Limiting their work to not include students that had taken time off, the researchers found that nearly 25% of the students from the highest quartile of socio-economic status families also took developmental classes at the college level. They claimed that a large proportion of students that graduated from high schools in rural and suburban areas take basic skills classes in college, but students that are from more privileged families and areas do too. They concluded that "these classes are not to preserve a small group of 'academic incompetents' who have no hope of success in higher education" (p. 914). Rather, continuing to offer these programs produces a wide sweep of education that reaches all levels of citizens.

Finally, many researchers set out to determine whether developmental programs have a causal impact on student retention and educational achievement. As discussed in the previous section, many opponents claim that there is no such relationship and that developmental programs in fact contribute to a student's lack of success. Yet other research refutes these claims. For one, Bahr (2010b) found that, overall, students that completed the developmental mathematics requirements had similar and sometimes superior academic outcomes in comparison to those that did not need remediation. Lesik (2007) conducted a regression-discontinuity research design and found that the retention rate for developmental math students improved when compared to the retention rate of students who did not participate in these classes. In particular, 88.7% of the developmental students were still enrolled after the second semester in comparison to a second-year enrollment of 62.7% for the students that did not take developmental courses. Bettinger and Long (2005) found that students in developmental courses did as well as similar non-developmental students. Further, their work appeared to show improved student outcomes as a result of mathematics remediation, with developmental students being 15% more likely to transfer to a four-year institution.

Bettinger and Long (2009) completed another study using an instrumental variables strategy and held that students in developmental courses had a higher persistence rate than those with similar backgrounds that did not enroll in remedial classes. The developmental students were 12% less likely to drop out and 11% more likely to graduate when compared to the non-developmental students with similar background characteristics. Kolajo (2010) found that, depending on the number of developmental courses required, the developmental students performed as well in the college-level course as did those that did not require remediation.

Attewell, Lavin, Domina, and Levey's (2006) and Kolajo's (2010) findings refute the arguments that developmental programs are a death sentence and that students that take these classes are not only sub-standard when it comes to college-level skills, but will not persist to completion. The former researchers wrote the following:

> On average, students who took remediation at a two-year college had significantly lower graduation rates than students at the same kind of institutions who did not take remedial coursework. However, after we add controls for family background and academic performance in high school, this effect is reduced to non-significance. We interpret this as meaning that taking one or more remedial courses in a two-year college does not, in itself, lower a student's chances of graduation. Causal factors that do reduce one's chances of graduating include low family socio-economic status, poor high school preparation, and being Black, but not college remediation, *per se*. (p. 905)

Using their counterfactual model of causal inference, they were able to separate coursework from background in order to more accurately analyze the credibility of these courses. The latter (Kolajo, 2010) found that, for students requiring only one developmental class, the GPA was the same as students that did not require remediation (3.25 weighted average GPA for three academic years).

Some camps against developmental programs list the additional time to degree as a hindrance. Although Attewell, Lavin, Domina, and Levey (2006) found this to be true, the actual time was extended by only two or three extra months – not years as claimed by those pushing to do away with developmental classes in college. They even found that the number of developmental courses required was not a problem, although this is a complaint by those against developmental programs. As stated in the disadvantages earlier, some say that the more remedial courses required results in less of a chance for academic success. Yet Attewell, Lavin, Domina, and Levey found that, after removing causal factors, students needing three or more developmental classes were not disadvantaged when compared to equivalent students (academically) who took none or less than three developmental classes. In fact, they claimed that "there is evidence among two-year college entrants that students who passed remedial courses had better educational outcomes than did similar students who never took remedial courses" (p. 912). There were no negative effects in regards to earning a degree for developmental students at two-year institutions, but this was not the case for four-year institutions. The group found that developmental classes did have a significant impact on lower graduation rates for students at four-year institutions. For one, when using a logistic regression analysis, students at two-year institutions that passed all math remediation had a 39.73% graduation rate compared to the non-remedial group, which had a 28.76% graduation rate. Students that passed developmental reading and developmental English both saw better graduation rates with a difference in about ten percentage points and about thirteen percentage points, respectively. However, the numbers for four-year institutions were reversed. Students that passed developmental math saw a one percent decrease in graduation rate, while developmental reading and English saw about six percent and four percent decreases, respectively. The work by Attewell, Lavin, Domina, and Levey did not work into the analysis possible reasons for these results, but the drop in numbers alone warrants concern.

In summary, despite the number of critics opposed to developmental education at the college level, there are many scholars and practitioners that continue to stand up for the benefits that these classes provide for underprepared students. Regardless of the voices for and against these basic skills programs, many colleges continue to offer the services for students not ready for college-level work.

Number of colleges offering developmental programs. The necessity of developmental programs has become so widespread that a vast number of American institutions of higher education are offering these courses. In fact, considering both public and private organizations in the data from Table 1, over 67% (67.1%) of all four-year institutions and almost 76% (75.9%) of all two-year institutions offered remedial services in the 2011 – 2012 academic year (NCES, 2012b). Looking at the public domain only, the numbers increase. Out of all U.S. public institutions in 2011 – 2012, almost 90% (89.6%) of institutions made developmental classes available to students, which consists of over 75% (75.7%) of all four-year colleges and universities and over 99% (99.5%) of all two-year colleges (NCES).

A striking aspect of Table 1 shows the decline of the developmental programs being offered in postsecondary institutions, both public and private. The only steady increase over the last decade is in the private, for-profit domain. Since public institutions rely on federal and state appropriations and many colleges have seen drastic budget cuts from 2001-2002 until 2011-2012, perhaps these programs are being cut for financial reasons (along with the voices of opposition discussed earlier). Twenty-two states and systems of higher education in the United States have either done away with completely or greatly reduced the amount of remedial classes offered to students (Parker, 2007).

Table 1

Percentage of Degree-Granting Institutions Offering Remedial Services, by Level of Institution: 2001-02 Through 2011-12

Year	Public and private			Public			Private								
										Nonprofit			For-profit		
	Total	4-yr	2-yr	Total	4-yr	2-yr	Total	4-yr	2-yr	Total	4-yr	2-yr	Total	4-yr	2-yr
2001-02	73.3	69.0	79.5	92.3	79.9	99.4	60.2	65.3	45.0	66.1	65.5	72.6	48.0	64.5	37.3
2011-12	70.4	67.1	75.9	89.6	75.7	99.5	60.0	64.6	46.3	60.2	60.3	59.0	59.8	73.8	44.4
Change in percentage points	-2.9	-1.8	-3.6	-2.7	-4.3	0.1	-0.2	-0.7	1.3	-5.9	-5.2	-13.6	11.7	9.3	7.1

(NCES, Table 375, 2012b)

Students Needing Developmental Mathematics

Regardless of the arguments surrounding developmental education, colleges still offer the courses and students still need the training. Developmental education has been around for centuries due to the widespread necessity of what the classes offer. Many students in postsecondary education utilize what developmental programs provide for those that are underprepared for college-level work. This section looks at the number of students that require developmental education in general, and then places a focus on developmental mathematics. Further attributes such as gender, age, and race are addressed as they relate to enrollment and success in developmental classes.

From Table 2, higher education has seen a 91% increase in fall enrollment from 1976 to 2011 in all degree-granting institutions (NCES, 2012a). Although this is a slight decrease from 2010 to 2011, postsecondary education serves more students than in the previous decades. Focusing on two-year institutions, there has been a slightly larger increase at about 93% (NCES).

Moving from a national viewpoint to a focus on the state of Alabama, the Alabama Commission on Higher Education [ACHE] (2011) estimated that 34.4% of the high school graduates in 2010 reported taking at least one remedial course when they entered a public two-year or public four-year institution in the state. Further, the Birmingham city school district, which is one of the lowest performing systems in the state, saw 50% of its 2010 graduating class that went to college take a remedial course in a public two-year or public four-year college in Alabama. The organization goes on to claim that the problem is not isolated to this state alone. Alabama's averages are similar to most national figures. Altbach, Gumport, and Berdahl (2011) found that 40 percent of college students in the nation require at least one preparatory course.

Table 2

Total Fall Enrollment in Degree-Granting Institutions by Level of Institution: Selected Years, 1976 through 2011

Level of institution	Fall enrollment (in thousands)										
	1976	1980	1990	2000	2005	2006	2007	2008	2009	2010	2011
All	10,985.6	12,086.8	13,818.6	15,312.3	17,487.5	17,7583.9	18,248.1	19,102.8	20,427.7	21,016.1	20,994.1
4-year	7,106.5	7,565.4	8,578.6	9,363.9	10,999.4	11,240.3	11,630.2	12,131.4	12,906.3	13,335.3	13,494.1
2-year	3,879.1	4,521.4	5,240.1	5,948.4	6,488.1	6,518.5	6,617.9	6,971.4	7,521.4	7,680.9	7,500.0

(NCES, Table 264, 2012a)

From Table 3, if 40.9% of first-year undergraduates at two-year institutions reported ever taking a remedial class in 2008, and if the total enrollment for those institutions for that year were reported at 6,971,400 students (NCES, 2012c), then over 2.8 million students required remediation. Also from Table 3, assuming almost 75% of these students tested into developmental mathematics at this level (NCES), over 2.1 million students are at risk in that one year alone are affected either positively or negatively by their developmental math class(es). Institutions have the call of not only evaluating, but effectively evaluating the programs being offered since the success of so many students is on the line.

Table 3

Percentage of First-Year Undergraduates Who Reported Ever Taking a Remedial Course, by Level of Institution and Race/Ethnicity: Academic Years 2003-04 and 2007-08

	2003-04			2007-08		
Race/ethnicity	All institutions	4-year	2-year	All institutions	4-year	2-year
Total	34.7	27.1	39.9	36.2	28.8	40.9
White	31.7	25.0	36.2	31.3	24.2	35.8
Black	41.2	36.3	46.0	45.1	38.1	50.2
Hispanic	37.5	27.9	44.6	43.3	38.4	48.6
Asian	39.6	28.8	46.5	38.0	27.9	42.8
Native Hawaiian/Pacific Islander	40.8	37.0	44.0	40.0	20.8	44.9
American Indian/Alaska Native	44.8	25.6	54.6	46.8	35.6	53.2
Two or more races	33.9	26.0	40.3	32.8	27.3	36.8

(NCES, Table E-39-1, 2012c)

Developmental mathematics. Students requiring developmental classes may place in one or more courses that provide skills for reading, writing, and/or mathematics. This study focuses on developmental mathematics. More often than not, students require remediation in mathematics more than any other subject (Adelman, 2004b; Attewell et al., 2006; Bahr, 2007, 2013; Cullinane & Treisman, 2010; Hoyt, 1999; Le et al., 2011; Parsad & Lewis, 2003). In particular, Parsad and Lewis found that, in fall 2000, entering freshmen required remediation in mathematics more than any other subject. This was true for both public 4-year and public 2-year institutions. Similarly, Hoyt looked at a cohort of entering freshmen in the 1993, 1994, and 1995 academic years (and stopped tracking in 1998). Of all the students in that cohort enrolled at Utah Valley State College, 44% required developmental mathematics, 34% required developmental English, and 12% required developmental reading. Additionally, Adelman saw that developmental math was required for the students in his study more than any other developmental subject. Finally, a 2006 – 2007 report found that almost 75% of students tested into developmental mathematics classes at the community college level (Bonham & Boylan, 2011).

Sadly, students are more likely to *fail* developmental mathematics than any other college course (Le, Rogers, & Santos, 2011). Along these lines, Le, Rogers, and Santos found that only ten percent of the students that began three levels below college-level math ever completed a math course that counted at the college level. Similarly, developmental mathematics courses made up the top three courses in all of postsecondary education in which students either failed or withdrew (Adelman, 2004a). What makes this even more disturbing is the finding that most remedial mathematics students who do not complete college-level math do not reach their academic goals (i.e., graduate or earn a certificate) (Bahr, 2010b).

Gender. When it comes to placement in developmental courses, attitudes and motivation to stay in school tend to diminish and feelings of inferiority may begin to arise (Walker & Plata, 2000). This holds true when it comes to gender in developmental mathematics as well. In particular, Rawley (2007) found that a female's self-efficacy, or belief in one's ability, played a role when it came to enrolling in and completing a mathematics course. Further, Gunderson, Ramirez, Levine, and Beilock (2012) found that females seemed to have a more negative attitude toward mathematics when compared to males, and that these attitudes greatly affected performance in those classes.

On the other hand, when analyzing performance in mathematics courses with respect to gender, some find opposite outcomes. First, Fike and Fike (2007) found that females had higher course completion rates than males in all developmental classes ($\chi^2(1, 1318) = 29.139$, $p < .001$). Walker and Plata (2000) studied 500 students in three developmental mathematics courses. The females placed in the preparatory courses performed as well as their male counterparts. Similar findings were reported by Cooper and Robinson (1989) and House and Wohlt (1989). Even more contradicting is a study by Spradlin and Ackerman (2010), which found that females outperformed males in college-level math as well as developmental classes. This was echoed in studies by Porter and Edgar (1987) and Rech (1996).

Age. Moving from the student characteristic of gender to that of age, not as much disparity exists in the literature. For instance, Fike and Fike (2007) found that older students had higher grades and higher rates of successfully completing courses than younger students (Point Biserial $r = .108$, $p < .001$, $n = 1318$). Additionally, Walker and Plata (2000) classified a "younger group" as students between the ages of 18 and 26 and the "older group" to be students over the age of 26. In their work, there were a greater number of older students placed in developmental mathematics than the younger group. Moreover, there were more than the expected number of older students and fewer than the expected number of younger students in the lowest developmental course, which they titled foundational math. Yet age was positively correlated to performance in developmental mathematics in the study by Walker and Plata, a work by Wolfle (2012), and one by Penny and White (1998). Similarly, in Kolajo's 2010 study, the developmental group had an average age of 30 compared to the group that did not need remediation with an average age of 25. So there is something to be said regarding age and developmental versus non-developmental status.

Race/ethnicity. Developmental education enrollment trends regarding race/ethnicity are similar to that of age in that a group seems to be overrepresented with respect to the others. Although race, in and of itself, is not the cause of this disparity, there are many elements of inequality that lead to lower preparation and lower achievement for underrepresented groups (Bahr, 2010a). Particularly, Bailey, Jeong, and Cho (2010) found that non-White students were more likely to be placed in developmental education at community colleges than any other race. This fact was also found by Walker and Plata (2000) and Bahr (2010a) in earlier studies. On a similar note, Goldstein, Burke, Getz, and Kennedy (2011) analyzed developmental enrollment in the California State University system. They found that non-White students were much more likely to place in developmental mathematics.

On top of more frequent placement, underrepresented groups tend to have lower success rates than the majority group. The work by Goldstein, Burke, Getz, and Kennedy (2011) recorded the following developmental mathematics referral rates: 64% for African American students, 49% for Hispanic students, and 35% for Native American students, compared to only 21% for White students at the California State University system where the study took place.

With so many non-White students being placed in the training courses, some studies find that their chances of success are slim. In terms of performance at this level of classes, White students were more likely to succeed in the first college-level course after completing developmental education in comparison to students of color (Penny & White, 1998; Wolfle, 2012). Fike and Fike (2007) confirmed that finding by concluding that White students had a higher successful course completion rate than non-White students ($\chi^2(2, 1318) = 5.892$, $p = .053$). Similarly, Crisp and Nora (2010) recorded that 52% of the developmental students in their study were Hispanic and, of those, 35% did not persist or transfer into the second year and 41% did not persist or transfer into the third year. In addition, Cooper and Schleser (2006) saw that African American ($M = 103.44$, $SD = 15.48$) students performed significantly lower on mathematics achievement-tests than White ($M = 115.28$, $SD = 12.46$) students ($t(54) = 2.99$, $p < .01$), which revealed an innate disadvantage concerning skills necessary to succeed at the college level.

In conclusion, it is noted that there exists a great necessity for developmental education in the United States. A multitude of colleges offer these classes since thousands of students need the training. Because of the discrepancies found in the literature regarding gender as well as the trends shown above with respect to age and race/ethnicity, it seems warranted for this study to look at these demographic variables along with analyzing the effectiveness of a developmental mathematics program.

Effectively Evaluating Developmental Programs

Due to the controversies surrounding developmental education and the push toward a higher level of accountability for programs in higher education, evaluation is necessary. In many states, public institutions of higher education receive federal and state appropriations based on full-time equivalent enrollment at the beginning of the semester (National Conference of State

Legislatures [NCSL], 2013). This provides incentives for colleges and universities to increase enrollment, but leaves much to desire when it comes to what the organizations do to actually help students achieve academic success. NCSL displays how many states are moving away from enrollment-based funding and implementing funding formulas that factor in additional elements such as course completion and degree completion. The group notes that twelve states (Illinois, Indiana, Louisiana, Michigan, Minnesota, New Mexico, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee and Washington) already have funding formulas in place that incorporate variables like time to degree, transfer rates, or number of underrepresented or low-income students that graduate when calculating allocations. Four states have approved a performance funding formula, and several others have entered into formal discussions on implementing these types of changes (NCSL). President Barack Obama (2009) presented a plan to completely change how funding is distributed (more focus on outcomes than enrollment). Therefore, the need for effective evaluation has never been greater. And not for funding reasons alone. But program effectiveness, particularly in developmental programs, is vital to the students that need these services. If students are not getting the training necessary before entering college, then, even if the students pass the developmental class(es), the chances of progressing through to graduation diminish.

As previously noted, many issues both in opposition to and in support of developmental programs exist. With these two camps at such odds, it seems necessary to find ways to fix the problem. Accountability is on the rise, as are budget cuts. So many institutions are facing difficult times. With all of the doubt on the research methods that have been employed to date, much closer inspection concerning research design is being required by researchers (Moss & Yeaton, 2006). As institutions of higher education are facing these increasing demands (accountability, performance, etc.), a greater level of importance is being placed on more accurate program assessments (Kolajo, 2010). But even though there are thousands of students that arrive at the college level underprepared and in need of remediation, not much is known about the direct effects that developmental training has on student outcomes (Bettinger & Long, 2005). Some say the evidence that does exist is not demanding since it does not actually evaluate the effectiveness of these programs, which is surprising considering the important role they play in terms of the most common means of implementing policy and the cost of such programs (Calcagno & Long, 2009).

Schiel and Sawyer (2002) found that only 21% of students that take developmental classes meet the requirements to successfully complete the course sequence. Even for those that pass the developmental courses, success is not assured. Only a small percentage of the students that take developmental mathematics ever pass the college-level course (Bailey et al., 2010). Since more students are lacking in math skills than any other subject (Bahr, 2007), this involves a large amount of students.

Paul Nolting listed possible reasons for this low success rate in his interview with Hunter Boylan (2011). The following is a summary of those factors. One problem involves the length of the developmental sequence. First, Boylan said it takes too long to progress into the college-level courses. Second, the developmental courses themselves have low success rates, so program effectiveness is a problem. Third, by nature of mathematics, the skills are progressive and students are required to master certain skills before moving on to the next level. This mastery does not always happen and students experience the snowball effect. Fourth, by nature of the material, abstract reasoning is required. Lower-level students usually have a hard time with ideas that are not concrete. Fifth, the anxiety associated with math leads to avoidance of the courses. Students that put off taking math classes only enhance the anxiety since they put pressure on themselves by saving math classes for the end of their program requirements. Sixth, many students arrive in college with deficiencies in math study skills. Studying math is different from studying other subjects, and many times students do not know this when taking a course. Seventh, students are rarely just students anymore, and when personal problems occur, the math class is usually the first to go. Eighth, if poor instruction was the reason for the lack of skills, repeating students usually get the same type of instruction that led to the original low performance Ninth, from a global perspective, societal norms accept failure in math. Therefore, by understanding the issues that students face when it comes to developmental mathematics, perhaps practitioners can remedy the situation to improve the experience for everyone involved. In order to improve the experience, an effective form of program evaluation needs to be conducted.

Along with the need for program evaluation lies the necessity to analyze the data in a meaningful manner. Since fewer than half of all students that are required to take developmental classes finish the sequence (Bailey et al., 2010), institutions of higher education have the task of evaluating these programs for efficiency. Although few evaluations of remedial education exist, those conducted are considered useless due to their lack of recommendations of how to improve because they do not look at what these programs actually do (Grubb, 2001). Outcomes measures should be systematically developed that include not only test scores of basic skills, but persistence to completion and completion of degrees (Bahr, 2008b). Earlier the voices of opposition to developmental education were presented. But Bailey (2009) refutes much of these claims since the research conducted does not adequately measure the success of developmental programs or distinguish between various approaches to these courses. Outcomes such as completion of remedial courses, persistence, earning credits, transfer, and degree completion are items that should be studied longitudinally in order to indicate program effectiveness (Collins, 2010).

As stated earlier, not only do programs need to be evaluated, but they need to be evaluated effectively. Boylan, Bonham, and Bliss (1997) complained that only a small percentage of developmental programs conduct methodological evaluation that is ongoing. Levin and Calcagno (2008) saw that there was a lack of data available on the effectiveness of developmental education and how well these courses improve the skills of underprepared students. They pointed out that, with a large percentage of students enrolling in such courses, there is still little research on their effectiveness. They also found that there is almost no evidence as to whether remedial classes improve students' chances of success since rigorous studies are not being conducted. They claimed that "there is in fact little definitive evidence on the effectiveness of remedial courses and practices on persistence to graduation, quality of performance in subsequent courses, grade point average, and so on in the relevant literature" (p. 4). Much work needs to be done when it comes to effectively evaluating developmental mathematics.

Bahr (2010b) said that the empirical evidence is limited and that a strong critique of higher education is the lack of sound, complete evaluations of these programs. Bettinger and Long (2009) concurred that, although remedial courses are used extensively, little is known about their effects on student success. They criticized the fact that most states do not have "exit standards for remedial courses and do not perform systematic evaluation of their programs" (p. 3). Grubb (2001) pointed out that institutions do not even know if their developmental education works since most states have not even evaluated these programs. Collins (2010) also found that there is a great need for evidence to show the effectiveness in developmental education, however, there is little "systematic evaluation of programs and improvement strategies that validate claims of effectiveness" (p. 3).

Bailey, Jeong, and Cho (2010) also found that there is little research that examines how a student progresses through the developmental program and into college level courses. An interesting point they made was that, even if a student does not pass the developmental courses, all is not lost. It might be that they learned valuable skills even though it was not enough to prepare them for college level work. This is still a benefit to society. Moving from a fifth grade reading level to a tenth grade reading level is considered successful to many people, even if no certificate or degree was earned. Merisotis and Phipps (2000) stated that data on the effectiveness of remedial programs has not been fluid, has not been adequately funded, and has not been comprehensive or complete. Koski and Levin (1998) claimed that there is a scarce amount of reliable research regarding student achievement and persistence for those that begin in developmental education.

According to the work by Boylan and Saxon in 2010, many institutions are either not measuring the success of their developmental programs at all or fail to track the right data. They claimed that the field is being criticized because, even though the programs affect tens of thousands of students, there is little evidence that the best type of research is being used.

Continual and effective program evaluation is the only way to determine the effectiveness of developmental programs. A remedial course is not successful unless it provides its students with the proficiency and critical thinking skills necessary to reach course objectives and be successful at the next level. In particular, developmental mathematics needs intense evaluation. Le, Rogers, and Santos (2011) found that students in developmental math usually do the worst in other courses. They also claimed that students are more likely to fail developmental math than any other college course. Attewell, Lavin, Domina, and Levey (2006) backed up this claim by stating that only 30% of students pass their developmental mathematics course(s), and that research should look at the role remediation plays in the likelihood of graduation as well as the time it takes to earn a degree. Administrators and faculty are charged with the task of not only constantly measuring the effectiveness of the developmental mathematics program due to the important role it plays in higher education, but of also measuring it in a manner that is meaningful to the program's mission.

Further, the data to collect is quite important. Grubb (2001) claimed that there needs to be a systematic collection of ways to measure outcomes. Yet these measures need to be more than simply gathering test scores. They should include persistence to degree, portfolios, and completion of technical courses. In 2010, Collins found that all evidence is not good evidence, and that completion of college-level courses, persistence, transfer, and graduation are measures that should be followed to indicate effectiveness.

Weissman, Bulakowski, and Jumisco (1997) concurred with Grubb and Collins. They stated that evaluation should "go beyond simply determining whether courses are effective and should examine the placement of students, the timing of remediation, and the eventual student enrollment in college level courses as measures of effectiveness" (p. 73). Nichols and Nichols (2005) had a similar stance. They stated that "completing developmental studies students can be tracked through their first college level course […]. An analysis can be made comparing the success rate of former developmental studies students and students not requiring developmental studies courses" (p. 214). They also included the fact that persistence to graduation for developmental students is another useful measure to use and collect data. Merisotis and Phipps

(2000) also found that the effectiveness of these programs should reflect how many students complete the remedial courses, how many continue on to complete college level classes, and how many reach their academic goals. Merisotis and Phipps have posited that remedial education should be evaluated based not only on how many students complete the preparatory classes, but also on how many continue on to and complete college-level courses and eventually reach their academic goals. Bailey, Jeong, and Cho (2010) agreed that the program evaluation should track student progression into the college-level courses. Even more specific is the idea that effective developmental program evaluation compares outcomes of remediated students with those that did not need remediation (Attewell et al., 2006; Bailey, 2009; Bettinger & Long, 2009; Calcagno & Long, 2009). Only then can the success of developmental programs be evaluated.

Dickeson (2010) acknowledged that, since the 1970s, higher education has shifted from inputs to more focus on outcomes. The Society of College and University Planning now stresses better data collection, uniform data between and among institutions for comparisons to be possible, and publications working toward a systematic means of measurement (Dickeson). However, many people are opposed to universities as "businesses" and students as "customers." And program evaluation in higher education is much more complex than in the business world. Yet the idea of tracking inputs to measure outputs is still useful in evaluating developmental education. Practitioners and administrators can follow the developmental students (inputs) in the first college-level course and track performance at that level (output).

Not only is effective evaluation beneficial to institutions in terms of improving student success and enhancing the developmental program, but it seems that student performance in the preparatory classes progresses as well. Boylan, Bliss, and Bonham (1997) found the following:

> Students in those programs which engaged in ongoing and systematic evaluation were generally more successful than those in programs which were not evaluated in this

> manner. The act of engaging in evaluation may enable program staff to monitor and improve performance in those components which do provide direct service to students. Without such evaluation, it is impossible to determine how successful various courses or activities may be. Unless developmental educators are aware of the impact […], they cannot improve. (p. 5)

Hence as soon as it is determined that something is not working, it can be phased out and new ideas can be implemented. Only then are students consistently getting the best that colleges and universities have to offer.

Conceptual Framework

This study utilizes a framework provided by Terenzini and Reason (2005). From their extensive research on student decisions in the first year of college, they found that this time frame is a make-or-break period for many students. The approach they developed, labeled as a college impact model, identified influences from students, faculty, and institutions that have an impact on the first year of learning and persistence. Honing in on the institutional aspect, they outlined seven characteristics that promote success and persistence in a student's first year. First, effective institutions develop policies toward a meaningful first year experience. Second, recruitment, admissions, and student transitions are intentional and aligned with the mission of the college. Third, effective institutions communicate the importance of the first year to faculty. Fourth, organizations promote success by communicating the importance of serving students based on their diverse needs. Fifth, institutions promote student engagement both inside and outside of the classroom to increase effectiveness. Sixth, effective institutions help students become functioning members of society by exposing them to diverse "ideas, worldviews, and people" (p. 4) in order to enhance their learning. And seventh, effective institutions continually assess and revise as needed according to evaluation data, other institutions, and professional affiliations.

The framework brings together four major elements that Terenzini and Reason (2005) have claimed are influential regarding student learning and change. First, students bring with them what the authors classify as precollege characteristics and experiences. This category includes a student's socioeconomic/demographic data, academic preparation and performance, and goals (personal, academic, career, etc.) that are brought with them to an institution. The second element in the model is the organizational context. From the seven items outlined above, effective institutions are intentional. These calculated measures include internal structures, policies, and practices; academic and co-curricular programs, policies, and practices; and faculty culture. So the institution must be ready to accept the student, along with their precollege attributes, in an effective way. Since it is virtually impossible for students to "live in isolation from one another," (p. 11) the third element is the peer environment. This category acknowledges that, although the individual experiences are the most important influence on student learning and change, the peer group is still important. But it means more than the general interaction with students in class or a student's close set of friends. The peer environment is made up of "the system of dominant and normative values, beliefs, attitudes, and expectations that characterize a campus' student body [and is] more easily sensed than measured" (p. 11). Within this peer environment rests the fourth and final category of individual student experiences. This set includes both in-class and out-of-class experiences, along with curricular experiences, that shape a student's learning and potential for success. They noted that it is important to acknowledge all of these in order to get a full picture of how students learn and grow during their college years. By tracking the items listed above, researchers and practitioners can obtain a glimpse of things that influence student outcomes such as learning, development, change, and persistence. Figure 1 provides a visual of their model.

Concerning potential uses for this college impact model, Terenzini and Reason (2005) suggested that it would be quite useful in "guiding studies that focus on the focus on [*sic*] the effects of academic departments […]" (p. 13). Therefore, this work utilizes aspects of the college impact model as a lens to conduct research. Following components of Terenzini and Reason's model, this study looks at student precollege characteristics such as age, gender, race, and math subtest scores (ACT/COMPASS). Outcome variables such as college-level math course pass/fail status, grade point average, graduation status, and persistence are tracked. Finally, items from the organizational context, the peer environment, and individual student experiences are valuable considerations that would be useful for future studies. By discovering whether relationships exist between student characteristics (precollege characteristics) and academic success (outcomes), faculty and administrators can make decisions regarding classroom experiences and other college environment experiences that best fit the needs of the students.

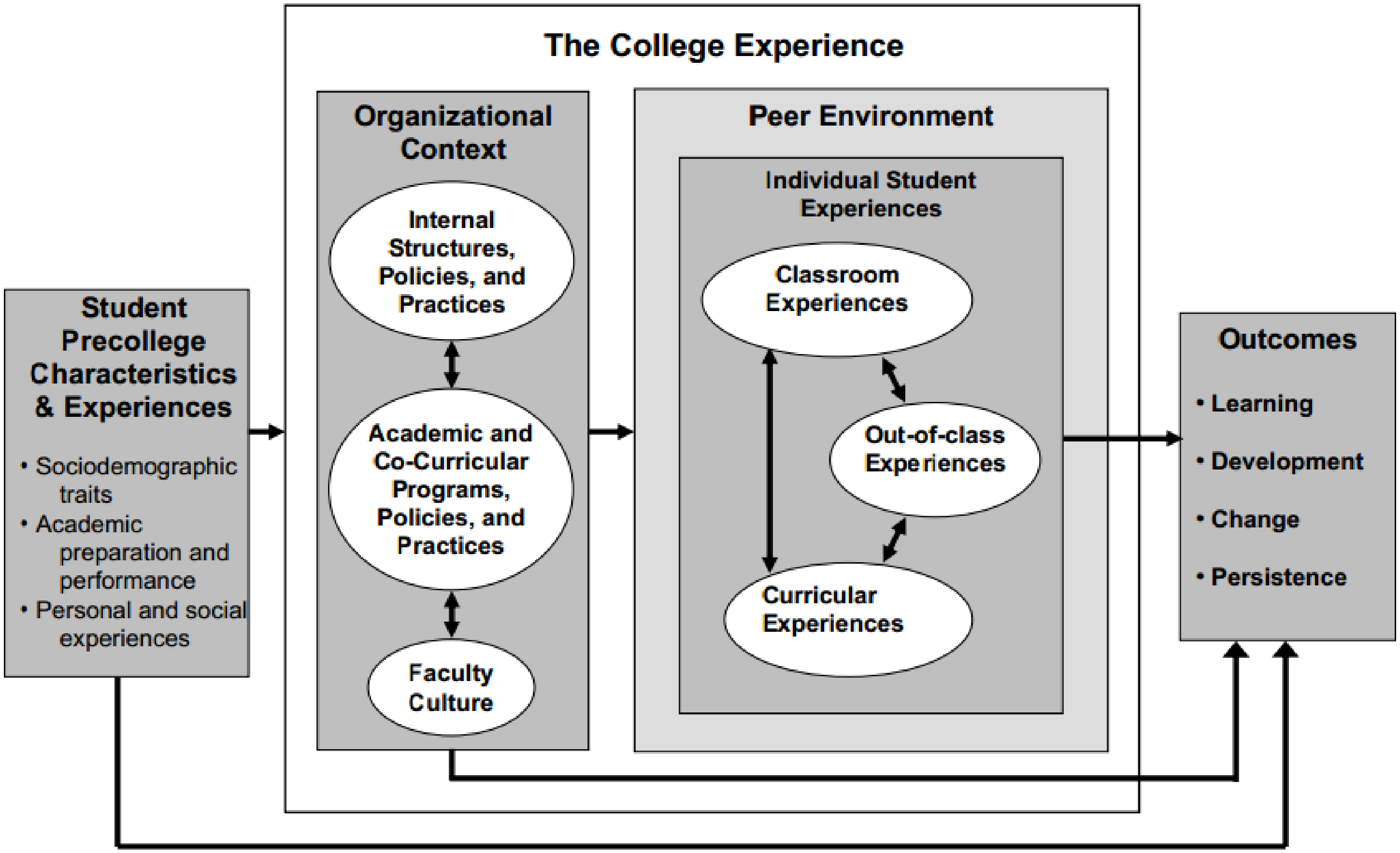

Figure 1. A comprehensive model of influences on student learning and persistence (Terenzini & Reason, 2005)

Conclusion

This chapter reviewed the literature relevant to certain areas of developmental education. First, the history of colleges offering preparatory classes to students underprepared for college work was outlined. Doing this provided a foundation for the importance of these classes and their relationship to American institutions of higher education. If colleges have a mission of providing a means of economic and social mobility, then developmental education, which is deeply rooted in our postsecondary history, serves that mission. Second, the literature concerning the necessity of developmental programs was explored. A look at the sheer number of colleges offering developmental programs was provided. Many institutions are under pressure to eliminate or cut back on these classes at the college level. The arguments voiced by both the opponents and the supporters of basic skills classes at the college level were presented. Next, the data available on the number of students needing remediation in college were outlined, with a focus on developmental mathematics. The research on students needing remediation was also discussed with respect to gender, age, and race. Finally, the review concluded with an overview of the opinions of previous scholars concerning the importance of evaluating developmental programs as well as an effective way to analyze these classes at the postsecondary level. A conceptual framework was also provided. The next chapter outlines the research methodology for this study that utilizes their recommendation of not looking only at the pass/fail status in the developmental classes, but comparing the pass/fail status of developmental students with non-developmental students. If the remediated group performed as well as the exempted group, then the developmental programs can be considered effective.

CHAPTER III:

METHODS

The purpose of this study was to determine the student characteristics that contribute to academic success at a community college in the Alabama Community College System. Doing so provides a glimpse of the effectiveness of the developmental mathematics program at the participating institution. This research used the remediated-exempted approach that compares various academic success measures for students that required developmental mathematics with the same measures for students that did not require developmental mathematics to determine course effectiveness. If developmental students perform as well as non-developmental students, then a program can be considered effective. Qualitative research methods generate descriptions and explanations as to how or why specified phenomena occur (Creswell, 2009) and are more subjective in an effort to give meaning to life experiences. Quantitative designs are more formal and systematic and look more at cause and effect in testing outcomes (Creswell, 2009). In order to determine the effectiveness of the developmental mathematics program at the participating institution, the use of a quantitative analysis has been demonstrated to generate useful results. Although utilizing a qualitative research design would provide valuable insight into related topics, the study sought to generate statistics useful to understanding the efficacy of developmental education.

This chapter provides the research methodology and procedures that will be used in the study, which is an adaptation of a study done by Boggs in 1997. The sections that follow include the rationale for the proposed research design; research questions, sub-questions, and hypotheses; population and sample; setting and environment; data collection procedures; data analysis procedures; bias and error; validity; reliability; limitations; and delimitations.

Rationale

Since many researchers conducted prior studies or recommended future work to utilize the remediated-exempted design (Bettinger & Long, 2005, 2009; Boggs, 1997; Dumont, 1982; Sawma, 2000; Smith, 1983), this study followed their recommendations. Dumont and Smith both concluded in their research studies that the remediated-exempted design was the best approach for evaluating developmental programs. Further, Sawma noted that it was beneficial to compare the success rates in the college-level classes of developmental students that passed the preparatory course(s) with the students that did not require developmental education. He limited his study by choosing not to look at gender, age, and ethnicity. However, he stated that adding those variables would positively add to the scope and size of the study.

Based on these suggestions, along with the pass/fail status in the college-level class, the work completed also compared the groups based on college graduation status, college grade point averages, and continuous enrollment. Additionally, the data were aggregated by ACT/COMPASS math subtest scores, as recommended by Bettinger and Long (2005, 2009) as well as Boggs (1997) due to the inherent differences among students in these two groups. Additional demographic variables such as age, gender, and race were used in the comparisons.

Based on the recommendations of Bettinger and Long (2005; 2009), Boggs (1997), Dumont (1982), Sawma (2000), and Smith (1983), the research design utilized was the remediated-exempted approach, along with addressing other characteristic variables pertaining to the students in the sample. To conduct the research, students enrolled in MTH 100 (the first college-level mathematics course) at the participating institution in the Alabama Community

College System were divided into two mutually exclusive (i.e. non-overlapping) groups: (a) students that were required to enroll in developmental mathematics before taking MTH 100, and (b) students that were not required to enroll in developmental mathematics before taking MTH 100. These two groups were compared based on the pass/fail status for MTH 100. Additionally, the two sets were compared based on the following: (a) college graduation status, (b) college grade point average, (c) college continuous enrollment, and (d) ACT/COMPASS math subtest scores. Finally, demographic variables such as age, gender, and race were tested in the study.

Representatives of the participating institution were contacted in order to receive permission to conduct the study. The Director of the Department of Institutional Planning and Research was notified of the intent to perform the research (see Appendices A and B). Confidentiality was upheld and no personal identifying information was reported according to the policy of the participating institution.

Research Questions and Hypotheses

The overarching research question for this study was as follows: What student characteristics contributed to academic success at the participating institution during the study period? The following constitutes the research sub-questions and hypotheses used in this study to answer the main research question.

1. Is there a difference between COMPASS math subtest scores of developmental math students and non-developmental math students? (Hypothesis 1: There will be no significant difference between COMPASS math subtest scores of developmental math students and non-developmental math students.)
    a. Is there a difference between COMPASS math subtest scores of male students with developmental math status and male students with non-developmental

math status? (Hypothesis 1a: There will be no significant difference between COMPASS math subtest scores of male students with developmental math status and male students with non-developmental math status.)

b. Is there a difference between COMPASS math subtest scores of female students with developmental math status and female students with non-developmental math status? (Hypothesis 1b: There will be no significant difference between COMPASS math subtest scores of female students with developmental math status and female students with non-developmental math status.)

c. Is there a difference between COMPASS math subtest scores of White students with developmental math status and White students with non-developmental math status? (Hypothesis 1c: There will be no significant difference between COMPASS math subtest scores of White students with developmental math status and White students with non-developmental math status.)

d. Is there a difference between COMPASS math subtest scores of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 1d: There will be no significant difference between COMPASS math subtest scores of non-White students with developmental math status and non-White students with non-developmental math status.)

2. Is there a difference between ACT math subtest scores of developmental math students and non-developmental math students? (Hypothesis 2: There will be no

significant difference between ACT math subtest scores of developmental math students and non-developmental math students.)

a. Is there a difference between ACT math subtest scores of male students with developmental math status and male students with non-developmental math status? (Hypothesis 2a: There will be no significant difference between ACT math subtest scores of male students with developmental math status and male students with non-developmental math status.)

b. Is there a difference between ACT math subtest scores of female students with developmental math status and female students with non-developmental math status? (Hypothesis 2b: There will be no significant difference between ACT math subtest scores of female students with developmental math status and female students with non-developmental math status.)

c. Is there a difference between ACT math subtest scores of White students with developmental math status and White students with non-developmental math status? (Hypothesis 2c: There will be no significant difference between ACT math subtest scores of White students with developmental math status and White students with non-developmental math status.)

d. Is there a difference between ACT math subtest scores of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 2d: There will be no significant difference between ACT math subtest scores of non-White students with developmental math status and non-White students with non-developmental math status.)

3. Is there a difference in age of developmental math students and non-developmental students? (Hypothesis 3: There will be no significant difference in age of developmental math students and non-developmental students.)

   a. Is there a difference in age of male students with developmental math status and male students with non-developmental math status? (Hypothesis 3a: There will be no significant difference in age of male students with developmental math status and male students with non-developmental math status.)

   b. Is there a difference in age of female students with developmental math status and female students with non-developmental math status? (Hypothesis 3b: There will be no significant difference in age of female students with developmental math status and female students with non-developmental math status.)

   c. Is there a difference in age of White students with developmental math status and White students with non-developmental math status? (Hypothesis 3c: There will be no significant difference in age of White students with developmental math status and White students with non-developmental math status.)

   d. Is there a difference in age of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 3d: There will be no significant difference in age of non-White students with developmental math status and non-White students with non-developmental math status.)

4. Is there a difference between the pass/fail status of developmental math students and non-developmental math students in the first college-level math course? (Hypothesis 4: There will be no significant difference between the pass/fail status of developmental math students and non-developmental math students in the first college-level math course.)

   a. Is there a difference between the pass/fail status in credit-level mathematics of male students with developmental math status and male students with non-developmental math status? (Hypothesis 4a: There will be no significant difference between the pass/fail status in credit-level mathematics of male students with developmental math status and male students with non-developmental math status.)
   b. Is there a difference between the pass/fail status in credit-level mathematics of female students with developmental math status and female students with non-developmental math status? (Hypothesis 4b: There will be no significant difference between the pass/fail status in credit-level mathematics of female students with developmental math status and female students with non-developmental math status.)
   c. Is there a difference between the pass/fail status in credit-level mathematics of White students with developmental math status and White students with non-developmental math status? (Hypothesis 4c: There will be no significant difference between the pass/fail status in credit-level mathematics of White students with developmental math status and White students with non-developmental math status.)

d. Is there a difference between the pass/fail status in credit-level mathematics of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 4d: There will be no significant difference between the pass/fail status in credit-level mathematics of non-White students with developmental math status and non-White students with non-developmental math status.)

5. Is there a difference between continuous enrollment of developmental math students and non-developmental math students? (Hypothesis 5: There will be no significant difference between continuous enrollment of developmental math students and non-developmental math students.)

a. Is there a difference between continuous enrollment of male students with developmental math status and male students with non-developmental math status? (Hypothesis 5a: There will be no significant difference between continuous enrollment of male students with developmental math status and male students with non-developmental math status.)

b. Is there a difference between continuous enrollment of female students with developmental math status and female students with non-developmental math status? (Hypothesis 5b: There will be no significant difference between continuous enrollment of female students with developmental math status and female students with non-developmental math status.)

c. Is there a difference between continuous enrollment of White students with developmental math status and White students with non-developmental math status? (Hypothesis 5c: There will be no significant difference between continuous enrollment of White students with developmental math status and White students with non-developmental math status.)

d. Is there a difference between continuous enrollment of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 5d: There will be no significant difference between continuous enrollment of non-White students with developmental math status and non-White students with non-developmental math status.)

6. Is there a difference between college grade point average of developmental math students and non-developmental math students? (Hypothesis 6: There will be no significant difference between college grade point average of developmental math students and non-developmental math students.)

   a. Is there a difference between the college grade point average of male students with developmental math status and male students with non-developmental math status? (Hypothesis 6a: There will be no significant difference between the college grade point average of male students with developmental math status and male students with non-developmental math status.)

   b. Is there a difference between the college grade point average of female students with developmental math status and female students with non-developmental math status? (Hypothesis 6b: There will be no significant difference between the college grade point average of female students with developmental math status and female students with non-developmental math status.)

c. Is there a difference between the college grade point average of White students with developmental math status and White students with non-developmental math status? (Hypothesis 6c: There will be no significant difference between the college grade point average of White students with developmental math status and White students with non-developmental math status.)

d. Is there a difference between the college grade point average of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 6d: There will be no significant difference between the college grade point average of non-White students with developmental math status and non-White students with non-developmental math status.)

7. Is there a difference between graduation status of developmental math students and non-developmental math students? (Hypothesis 7: There will be no significant difference between graduation status of developmental math students and non-developmental math students.)

a. Is there a difference between the graduation status of male students with developmental math status and male students with non-developmental math status? (Hypothesis 7a: There will be no significant difference between the graduation status of male students with developmental math status and male students with non-developmental math status.)

b. Is there a difference between the graduation status of female students with developmental math status and female students with non-developmental math status? (Hypothesis 7b: There will be no significant difference between the graduation status of female students with developmental math status and female students with non-developmental math status.)

c. Is there a difference between the graduation status of White students with developmental math status and White students with non-developmental math status? (Hypothesis 7c: There will be no significant difference between the graduation status of White students with developmental math status and White students with non-developmental math status.)

d. Is there a difference between the graduation status of non-White students with developmental math status and non-White students with non-developmental math status? (Hypothesis 7d: There will be no significant difference between the graduation status of non-White students with developmental math status and non-White students with non-developmental math status.)

8. Do interactions exist between pass/fail status in MTH 100 and gender, race, and developmental status? (Hypothesis 8: There will be no interactions between pass/fail status in MTH 100 and gender, race, and developmental status.)

a. Is there a difference between the pass/fail status in MTH 100 for developmental students and non-developmental students? (Hypothesis 8a: There will be no significant difference between the pass/fail status in MTH 100 for developmental students and non-developmental students.)

b. Is there a difference between the pass/fail status in MTH 100 based on gender? (Hypothesis 8b: There will be no significant difference between the pass/fail status in MTH 100 based on gender.)

c. Is there a difference between the pass/fail status in MTH 100 based on race? (Hypothesis 8c: There will be no significant difference between the pass/fail status in MTH 100 based on race.)

9. Do interactions exist between continuous enrollment and gender, race, and developmental status? (Hypothesis 9: There will be no interactions between continuous enrollment and gender, race, and developmental status.)

   a. Is there a difference between continuous enrollment for developmental students and non-developmental students? (Hypothesis 9a: There will be no significant difference between continuous enrollment for developmental students and non-developmental students.)

   b. Is there a difference between continuous enrollment based on gender? (Hypothesis 9b: There will be no significant difference between continuous enrollment based on gender.)

   c. Is there a difference between continuous enrollment based on race? (Hypothesis 9c: There will be no significant difference between continuous enrollment based on race.)

10. Do interactions exist between grade point average and gender, race, and developmental status? (Hypothesis 10: There will be no interactions between grade point average and gender, race, and developmental status.)

   a. Is there a difference between the grade point average for developmental students and non-developmental students? (Hypothesis 10a: There will be no significant difference between the grade point average for developmental students and non-developmental students.)

b. Is there a difference between the grade point average based on gender? (Hypothesis 10b: There will be no significant difference between the grade point average based on gender.)

c. Is there a difference between the grade point average based on race? (Hypothesis 10c: There will be no significant difference between the grade point average based on race.)

11. Do interactions exist between graduation status and gender, race, and developmental status? (Hypothesis 11: There will be no interactions between graduation status and gender, race, and developmental status.)

a. Is there a difference between the graduation status for developmental students and non-developmental students? (Hypothesis 11a: There will be no significant difference between the graduation status for developmental students and non-developmental students.)

b. Is there a difference between the graduation status based on gender? (Hypothesis 11b: There will be no significant difference between the graduation status based on gender.)

c. Is there a difference between the graduation status based on race? (Hypothesis 11c: There will be no significant difference between the pass/fail status in MTH 100 based on race.)

Population and Sample

The data used in this ex post facto study was pre-existing data for students enrolled in MTH 100, which is the first college-level mathematics course at the participating institution, during the 10-year period beginning fall semester 2002 and ending summer semester 2012. At the participating institution, students that score below 20 on the ACT or below 36 on the algebra level of the COMPASS placement-test are required to enroll in developmental mathematics before taking a college-level mathematics course. Students that score between 20 and 22 on the ACT or 36 or higher on the algebra level of the COMPASS placement-test are not required to enroll in developmental mathematics – these students are allowed to enter into MTH 100, the first college-level mathematics course. The students that took MTH 100 were placed in two mutually exclusive groups: (a) students that were required to take developmental mathematics (developmental math students), and (b) students that were not required to take developmental mathematics (non-developmental math students).

There were10,003 students in this study. Of those that qualified, 4656 (46.5%) were in the developmental math group and 5347 (53.5%) were in the non-developmental math group. Students in the developmental math group have the following characteristics:

1. an average age of 26.0;
2. an average GPA of 2.84;
3. an average COMPASS math subtest score of 81.73 (3931 of 4656 scores reported);
4. an average ACT math subtest score of 19.03 (612 of 4656 scores reported); and
5. an average of 6.44 semesters enrolled at the participating institution.

Students in the non-developmental math group have the following characteristics:

1. an average age of 23.1;
2. an average GPA of 2.71;
3. an average COMPASS math subtest scores of 92.21 (4584 of 5347 scores reported);

4. an average ACT math subtest score of 19.70 (1105 of 5347 scores reported); and

5. an average of 6.47 semesters enrolled at the participating institution.

The entire MTH 100 sample (10,003 students) was made up of 3760 (37.6%) males and 6243 (62.4%) females. Within this sample, the developmental math group consisted of 1572 (33.8%) males and 3084 (66.2%) females, with an average ACT math subtest score of 19.03 and an average COMPASS math subtest score of 81.73. The non-developmental math group consisted of 2188 (40.9%) males and 3159 (59.1%) females, with an average ACT math subtest score of 19.70 and an average COMPASS math subtest score of 92.21 (see Table 4).

Table 4

Summary of Student Characteristics

	Developmental math students	Non-developmental math students	Total/Avg
Total number (%)	4656 (46.5)	5347 (53.5)	10,003
Male students (% of all males)	1572 (41.8)	2188 (58.2)	3760
Female students (% of all females)	3084 (49.4)	3159 (50.6)	6243
Average age	26.0	23.1	24.6
Average GPA	2.84	2.71	2.78
Average COMPASS math subtest	81.73	92.21	86.97
Average ACT math subtest	19.03	19.70	19.37
Average number of semesters enrolled	6.44	6.47	6.46

Setting and Environment

The participating institution is located in northeast Alabama and is part of the Alabama Community College System. There are seven campuses that comprise this institution, which enrolled around 7,000 students at the time of data collection (GSCC, 2012). Reasons students enroll vary, which makes meeting student needs difficult. Some report attending in order to transfer to a four-year institution, and others intend to earn a certificate (the institution offers both short-term certificates and regular certificates). Some attend due to economic reasons like enhancing skills to earn a promotion or returning to school to change careers after suffering a lay-off. Some enroll due to the proximity of a campus to their home, and some simply due to the low cost. Along with these reasons, there are still some that enter the doors because it was the next expected thing after high school but, on the other hand, others are returning to complete a degree that was started years ago. Alabama has historically placed below average in educational attainment in the United State (U.S. Census Bureau, 2012). In 1990, Alabama ranked 48th in the country for the number of people that had at least a high school diploma, 46th place for a bachelor's degree or higher, and tied for 41st place for those with an advanced degree (U.S. Census Bureau). In 2000, the rankings were 46th (tie), 45th, and 41st (tie) for the number of citizens with at least a high school diploma, at least a bachelor's degree, and an advanced degree, respectively (U.S. Census Bureau). And in 2009, the rankings were 47th, 45th, and 41st for the same categories (U.S. Census Bureau). Choosing to look at a community college in rural areas of this state is important in order to evaluate the current state of and to improve the educational opportunities available to the citizens of Alabama.

The researcher for this study is a mathematics instructor at one of the campuses of the institution and teaches both developmental and college-level courses on a consistent basis. Although results have the potential of being damaging to the department, these results are reported honestly and openly. The researcher commits to displaying ethical behavior when conducting the analysis and interpreting the results.

Data Collection

The Programmer/Software Analyst at the participating institution generated a report that consisted of all students that enrolled in MTH 100 during the eleven-year period beginning fall 2002 and ending summer 2013. The researcher then took the records and compiled a spreadsheet document in order to identify the students, collect information on each student, and analyze the data. The spreadsheet file contained the information on each student as noted in Table 5.

Table 5

Data Collection Spreadsheet

Item	Data Collected and Relevant Codings
1	Semester and year enrolled in MTH 100
2	Student number
3	Grade earned in MTH 100 a. A passing grade (A, B, or C) was recorded as 1. b. A failing grade (D, F, or W) was recorded as 2.
4	Graduation a. Those that graduated or completed a program were coded as 1. b. Those that did not graduate or complete a program were coded as 2.
5	ACT math and/or COMPASS math subtest scores
6	Gender a. Males were coded as 1. b. Females were coded as 2.
7	Race a. Non-White was recorded as 1. b. White was recorded as 2.
8	Age at time of enrollment in MTH 100
9	Total semesters enrolled in college at time of data collection
10	Cumulative grade point average at time of data collection
11	Developmental math status a. Developmental math students were coded as 1. b. Non-developmental math students were coded as 2.

Reviewing this data resulted in two mutually exclusive groups – developmental mathematics students and non-developmental mathematics students. The records generated in the spreadsheet were transferred to a statistical analysis software package (SPSS) in order to run tests and analyze results.

Research Instrument

The research instruments used in this research were the permanent digitally-stored student data records at the participating institution, the computers used to access the data, and the statistics software (SPSS) that was utilized to run statistical analyses on the data.

Research Variables

Based on the research questions, sub-questions, and hypotheses explored in this research, the dependent and independent variables are now identified. For each research question, the independent variables were developmental status, gender, and race. In question one, the dependent variable was the COMPASS math subtest score. For question number two, the dependent variable was ACT math subtest score. The third research question used age as the dependent variable. Research question number four utilized pass/fail status in MTH 100 as a dependent variable. The fifth research question had a dependent variable of continuous enrollment. The sixth research question utilized the dependent variable of college grade point average. The seventh research question used graduation status as the dependent variable. Finally, the eighth, ninth, tenth, and eleventh research questions used pass/fail status in MTH 100, continuous enrollment, grade point average, and graduation status, respectively, as dependent variables. See Table 6 for a complete list of questions, variables, and test statistics used to answer each question.

Data Analysis

There were eleven research questions utilized in this research, each of which had three to foursub-questions. Thus there were fifty-one null hypotheses analyzed. Ten were analyzed using Chi-square test of association and twenty-five were examined using a one-way analysis of variance (ANOVA). Eight were analyzed using a two-way ANOVA, and eight were analyzed using a logistic regression. In many cases, the homogeneity of variance assumption required to run a one-way ANOVA test was violated, so Welch's Robust test table was read instead of the ANOVA table. A summary of the research questions, variables, and statistical analysis tests are provided in Table 5.

According to Creswell (2009), a Chi-square analysis is recommended when there is a single categorical independent variable and a single categorical dependent variable. This type of analysis was used to determine if there is a significant difference between the pass/fail status of developmental math students and non-developmental math students in the first college-level math course, aggregated by gender and race. The Chi-square test for association was also used for determining if there is a significant difference between the graduation status of developmental math students and non-developmental math students, aggregated by gender and race. When the test statistic is significant, the cell or cells that produced the significance was reported by comparing the size of the standardized residuals to the critical values of ± 1.96.

Creswell (2009) stated that ANOVA tests are recommended when studying one or more categorical independent variables and one continuous dependent variable. To determine if there is a significant difference between the grade point average of developmental students and non-developmental students, an ANOVA analysis was attempted since GPA is a continuous variable. An ANOVA analysis was also attempted to tell whether there is a significant difference between the continuous enrollment of developmental students and non-developmental students. ANOVA analyses were used to determine whether there is a significant difference in age, COMPASS math subtest scores, and ACT math subtest scores of the developmental and non-developmental groups, as well as to explore the existence of any interaction effects among the variables.

Additionally, Creswell (2009) claimed that a logistic regression be used when the dependent variable is continuous and there are one or more independent variables that are either continuous or categorical. This type of analysis is used to predict the probability that an observation falls into one of two categories of a dichotomous dependent variable based on one or more independent variables that can be continuous or categorical. In order to look at interaction effects for the dichotomous academic outcome variables used in this analysis (pass/fail status in MTH 100 and graduation status), a logistic regression analysis was used.

The statistical package SPSS was used to conduct the analyses at a computer station located in the computer lab at The Gadsden Center of The University of Alabama or at the computer located in the office of the researcher in this study. The value of $p < .05$ was used as the significance level for all tests performed, which indicates 95% accuracy.

Table 6

Research Questions, Variables, and Test Statistics

Research Question	Independent Variable	Dependent Variable	Test Statistic
1	Developmental status	COMPASS math subtest score	One-way ANOVA
1a, 1b	Gender		
1c, 1d	Race		
2	Developmental status	ACT math subtest score	One-way ANOVA
2a, 2b	Gender		
2c, 2d	Race		
3	Developmental status	Age (at time of enrolling in MTH 100)	One-way ANOVA
3a, 3b	Gender		
3c, 3d	Race		
4	Developmental status	Pass/fail status in MTH 100	Chi-square
4a, 4b	Gender		
4c, 4d	Race		
5	Developmental status	Continuous enrollment	One-way ANOVA
5a, 5b	Gender		
5c, 5d	Race		
6	Developmental status	Grade point average	One-way ANOVA
6a, 6b	Gender		
6c, 6d	Race		
7	Developmental status	Graduation status	Chi-square
7a, 7b	Gender		
7c, 7d	Race		
8		Pass/fail status in MTH 100	Logistic regression
8a	Developmental status		
8b	Gender		
8c	Race		
9		Continuous enrollment	Two-way ANOVA
9a	Developmental status		
9b	Gender		
9c	Race		
10		Grade point average	Two-way ANOVA
10a	Developmental status		
10b	Gender		
10c	Race		
11		Graduation status	Logistic regression
11a	Developmental status		
11b	Gender		
11c	Race		

Unit of Analysis

Since this study compared student performance in the credit-bearing mathematics course at the participating institution, along with other student characteristics and performance indicators, the unit of analysis for this research was the individual student records at the community college.

Bias and Error

The remediated-exempted research design is useful in that it shows whether the students actually benefited from remediation. Many developmental programs simply report pass rates in the developmental classes to show effectiveness. However this has no reflection on how well the students do in the mathematics course that counts toward a certificate/degree. Since passing the college-level course is a requirement to eventually earn a degree or meet program requirements, those measures are of high importance. This same advantage can be seen as a point of error since the two groups of students (developmental and non-developmental) are inherently different when it comes to skill level, knowledge, prior training, etc. Therefore this study chose to look at ACT/COMPASS math subtest scores in order to generalize whether the developmental students were being compared to a group that was similar in ability, and whether they truly overcame deficiencies by taking the developmental math course(s).

The graduation status reported can be misleading. The mission of the participating institution is not limited to seeing students graduate. Many attend and gain credentials in order to earn an increase in wages or earn a promotion. Others enroll in order to complete transfer courses and never fill out the paperwork to graduate since a two-year degree in their declared major is not the ultimate goal. Still others enroll on a transient status, take a class or two, and return to their primary institution. Therefore a low graduation status in general may not imply poor academic achievement.

The following items constitute potential errors in the study. First, coding errors by the records and/or IT department could skew the results. Second, the participating institution converted over to a new data system during the study period. During this conversion, old ACT and COMPASS scores were not rolled over. Since these scores expire after three years, the IT department did not transfer old scores. Third, the ages reported by the IT department are at most one day less than one year off the mark. Since the person reporting the data could not access the age at the time of enrollment in MTH 100, age was computed by finding the difference between the age of enrollment at the institution and the semester and year of enrollment in MTH 100. Fourth, it is possible that students were allowed in MTH 100 without an ACT or a COMPASS score. If an override was conducted that allowed this to happen, the student would have no math subtest scores on record. These cases were removed from the calculations and analyses.

Validity

There are many factors that contribute to student success and, subsequently, lack of success. Many of these items cannot be controlled. Thus there is a level of internal validity that is lacking in this study since motivation, family and peer support, job obligations, family obligations, transportation, illness, death, etc. will not be part of the research design. However, many of the variables chosen will provide a level of certainty that the intended outcome (academic success) could be a result of the cause (developmental status). External validity is mixed as well. Since this research was done at a single institution, and all institutions have students of varying skills and backgrounds, then the results may not be generalizable to other institutions. However, the methodology, research design, results, and literature discussed can be utilized at other institutions that wish to have a model for effectively evaluating their developmental programs.

Reliability

The reliability of this study lies in the fact that data collection is subject to the policies implemented by the participating institution. Coding errors by the records department will not be controlled in this study. Since the data collected for the research is usually mandated to be kept as permanent records, researchers can replicate this study as these variables will be available over time.

Limitations

This study was limited to data collected from records of fall 2002 through summer 2013. This study was also limited to a rural, public two-year system in Alabama, which restricts the ability to generalize the results to all types of higher education institutions. Items such as course design, teaching methodology, student goals, and student motivation potentially play a role in student performance and success and would be excellent variables for future studies. Yet the scope of this study does not incorporate these factors (Boggs, 1997).

A limitation of this study was in the design of using graduation status as a unit of analysis. Students attend community colleges for a variety of reasons, many of which do not include the goal of graduating. Since some attend to enhance workplace skills and some attend to gain training to take back to the workplace, graduation is not achieved. Many students enroll in a community college in an effort to complete core coursework to transfer to a four-year institution. If employers do not recognize only two years of education in that major, many do go through with the requirements of applying for and attending graduation unless it is a personal goal. For instance, consider a student that is an education major. It is highly unlikely to earn a job as a school teacher with only two years of education in that field. State certification regulations require a four-year degree. Thus many students do not see the necessity in completing the requirements to graduate with an associate's degree in education.

For the reasons listed above, the graduation statuses in this study were understandably low. Additionally, the research was cut off after summer 2013. It is possible that students used in the study graduated after summer 2013, but they were not counted as graduates for purposes of this research. Also, it is possible that many of the students in the study transferred to another institution and graduated. Again, due to limitations of this research design, those students were not counted as graduates.

Other occurrences outside the control of the institution that this study did not include are employment, illness, death, family responsibilities, imprisonment, financial responsibilities, military service, etc. (Sawma, 2000). No distinction was made regarding the quantity of developmental classes taken by a student. The participating institution offers two courses, Basic Mathematics and Beginning Algebra, that lead up to the first college-level math class (Intermediate Algebra). A student that placed in either no-credit class was labeled as "developmental." Finally, students are hindered from their studies by issues with transportation, need for childcare, access, commuting distance, and support (or lack thereof) from family or peers; this study does not include these variables in the data (Sawma).

Delimitations

This study was delimitated by the researcher in the following ways:

1. The decision to use a convenience sample of college students in a two-year institution of the Alabama Community College System limited the data;

2. The study did not focus on variables including but not limited to family support, maturity, motivation to succeed, and learning support services outside of the developmental classroom;

3. This study focused only on final grades earned in MTH 100, the first college-level mathematics course taken by students at the participating institution. Students might have enrolled in MTH 116 (Basic Mathematics with Applications) in order to meet the requirements for a certificate or associate in applied science degree. This study chose to look only at students enrolled in MTH 100 due to the rigor and algebra skills required to succeed. Additionally, MTH 116 was not considered since the course is not recognized as college credit by four-year institutions. Yet there are developmental students that do not enroll in MTH 100, but are successful in MTH 116. Thus the results are potentially lower than reality;

4. Graduation status was gathered using “graduation” and “graduation status” as operational definitions. The graduation statuses reported only included MTH 100 students who graduated from the participating institution during the 10-year period beginning fall semester 2002 and ending summer semester 2012. No attempt was made to follow up on students who might have either transferred to another institution or graduated elsewhere due to the difficulty in tracking (for one, many community college students take a break in their studies due to obligations outside of the classroom). Defining “graduation status” this way does not signify the actual and final graduation statuses of students enrolled at the participating institution during 10-year period beginning fall semester 2002 and

ending summer semester 2012, but served as a means of comparing the developmental and non-developmental students;

5. Continuous enrollment was tracked only through summer semester 2012. No attempt was made to gather enrollment data after summer semester 2012 in order to finalize the data gathered and run the analyses. Defining "continuous enrollment" this way does not signal the actual and final number of semesters of students who attended the participating institution, but served as a means of comparing developmental and non-developmental students;
6. One reason continuous enrollment and graduation status analyses yielded lower values than actual is due to cutting of the tracking of data. If students enrolled toward the end of the eleven-year period of the study, then perhaps these students have not had enough time to graduate and their continuous enrollment value is low;
7. It is possible that some students took developmental mathematics at another institution and scored high enough on the COMPASS placement-test to directly enter a college-level math class at the participating institution. This would qualify the student as a non-developmental math student at the participating institution since developmental classes do not bear college credit and rarely show up on a transcript. Only students who completed the developmental mathematics program at the participating institution were considered developmental students. All other students were considered non-developmental students;
8. It is possible that some students did not meet the requirements to successfully complete a developmental class but took the COMPASS math subtest and scored

high enough to enter the college-level course. In this instance, the student was considered a non-developmental student. The developmental group was made up only of students that took pre-college classes at the participating institution; and

9. The participating institution changed computer management systems during the study period. The former system did not ask enrolling students for ethnicity data since that was not required at the time. Therefore ethnicity was not available for a significant portion of the sample and was not included.

Summary

This chapter outlined the research methodology and methods that were utilized in this quantitative study that used a remediated-exempted design to determine student characteristics that contribute to academic success at a community college in the Alabama Community College System. Chapter IV presents the results of this study and Chapter V discusses the results, provides implications for practice, and also gives recommendations for future research.

CHAPTER IV:

ANALYSIS OF THE DATA

The purpose of this study was to determine whether developmental mathematics status and certain student characteristics had a relationship with academic success at a public two-year institution in Alabama. In particular, the independent variables developmental mathematics status, gender, race, age, and math subtest scores were tested to determine if there was a relationship with the dependent variables pass/fail status in MTH 100, college grade point average, continuous enrollment, and graduation. Analyzing the pass/fail status in the first college-level math class, continuous enrollment, college grade point average, and graduation status of both developmental and non-developmental students revealed whether the students that lacked necessary skills were able to overcome those gaps and have a chance of success in college. The previous chapter discussed the methodology utilized in this research study and outlined the research questions and hypotheses that were tested. Following a reminder of the population utilized in this research, this chapter presents the results obtained from the various statistical tests that were used to analyze the data. Each hypothesis is presented along with the statistical conclusion and statistical level of confidence. The sections that follow are devoted to addressing results from each of the eleven research questions. Finally, a summary of the results is presented.

Population Summary

There were 10,003 students that enrolled in MTH 100 during the time period between fall 2002 and summer 2013. The developmental students made up 46.5% of the group while the non-developmental students accounted for 53.5% of those studied. For pass/fail status in MTH 100, there were three students that enrolled with “audit” status and three students that had “withdraw passing” status upon completing the semester. These six cases were removed from the analysis only for the MTH 100 pass/fail status research questions. When working with the research questions concerning continuous enrollment, a decision was made to remove some cases as well. In the data, 99.8% of the population had been enrolled a maximum of twenty-three semesters. Those enrolled more than this (sixteen cases) were removed for this set of questions only. With questions involving race, there were 189 students that either did not report a race or reported their race as “unknown.” These cases were removed for all questions regarding race. For graduation status, there were 252 duplicates reported. In other words, there were 252 times when students in the sample earned more than one degree or certificate. In coding the data, only the first graduation record was kept. Therefore multiple degrees/certificates were not included in the analyses. For the questions using math subtest scores, an outlier was removed. A single record reported a 40 on the math portion of the ACT test. Since this is more than the maximum score possible, it was assumed that this was a transcription error by a representative at the participating institution and was removed from this set of research questions. Tables 7 and 8 offer a look at the population characteristics for each academic year in the study.

Table 7

Population Summary of Developmental Mathematics Students that Enrolled in MTH 100 between Fall 2002 and Summer 2013

Academic Year	Male	Female	White	Non-White	Age	Passed MTH 100	Failed MTH 100	Grade Point Average
2002-03	91	178	209	60	27.9	188	81	2.99
2003-04	143	241	283	101	27.5	234	150	2.91
2004-05	119	255	299	75	25.8	232	142	2.90
2005-06	133	250	310	73	25.6	235	148	2.86
2006-07	126	234	286	74	25.9	213	147	2.82
2007-08	119	226	275	70	24.9	212	133	2.79
2008-09	137	244	293	88	25.9	223	158	2.83
2009-10	172	436	466	142	26.0	360	248	2.86
2010-11	197	387	447	137	25.9	325	259	2.71
2011-12	168	332	361	139	25.2	253	247	2.77
2012-13	167	301	337	131	26.2	215	253	2.84
Total/Avg	1,572	3,084	3,566	1,090	26.0	2,690	1,966	2.84
Overall	4,656 (Gender)		4,656 (Race)			4,656 (Pass/Fail Status)		

Table 8

Population Summary of Non-Developmental Mathematics Students that Enrolled in MTH 100 between Fall 2002 and Summer 2013

Academic Year Enrolled	Male	Female	White	Non-White	Age	Passed in MTH 100	Failed MTH 100	Grade Point Average
2002-03	328	514	673	169	25.6	543	299	2.82
2003-04	186	276	380	82	23.7	311	151	2.90
2004-05	133	205	265	73	23.3	224	114	2.80
2005-06	131	208	268	71	23.1	249	90	2.77
2006-07	159	223	303	79	22.4	245	137	2.73
2007-08	187	235	337	85	22.4	275	147	2.72
2008-09	171	279	358	92	22.8	282	168	2.75
2009-10	244	385	453	176	23.0	378	251	2.62
2010-11	230	301	402	129	22.2	308	223	2.63
2011-12	225	284	384	125	22.7	292	217	2.57
2012-13	194	249	310	133	22.7	228	215	2.55
Total/Avg	2,188	3,159	4,133	1,214	23.1	3,335	2,012	2.71
Overall	5347 (Gender)		5347 (Race)			5347 (Pass/Fail Status)		

Results

The following sections constitute a discussion of the results of each of the eleven research questions.

Part One: COMPASS Math Subtest Scores

An ANOVA test was conducted for the research question and its sub-questions in this category. When the violation of homogeneity of variance was violated, Welch's Robust test table was analyzed rather than the ANOVA table. At the participating institution, students are not required to take the placement test as the entrance level may be determined using ACT scores or transfer courses. Additionally, the participating institution changed to a new database during the 2010-2011 academic year. If scores were more than three years old, they are no longer valid and were not transferred over to the new system. The numbers reported here are not the actual COMPASS scores reported from the tests. The COMPASS math subtest has progressive levels based on correctly answered questions. Since a student might score in at least one or at most all of the portions of the exam, the scores reported in the analysis are summations of each score reported in order to obtain a single value for a test score.

Hypothesis 1. There will be no significant difference between COMPASS math subtest scores of developmental math students and non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .006 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test) was used to determine if there was a difference in COMPASS math subtest scores for developmental students versus non-developmental students.

A significant difference was found, $F(1, 8{,}513) = 223.899$, $p < .001$. The mean COMPASS math subtest score for developmental students was 81.73 (±31.31) and the mean COMPASS math subtest score for non-developmental students was 92.21 (±33.26). Hypothesis 1 was rejected. This means that there was a significant difference between the COMPASS math scores of developmental students when compared to the COMPASS math scores of non-developmental students. The non-developmental students scored higher on the COMPASS math subtest than the developmental students. Table 9 shows the results of the ANOVA test (Welch's Robust test) and Table 10 shows the descriptive statistics.

Table 9

Results from ANOVA (Welch's Robust) Test Comparing COMPASS Math Subtest Scores of Developmental Students to Non-Developmental Students

	Statistic[a]	df1	df2	Sig.
Welch	223.899	1	8439.652	.000

a. Asymptotically F distributed.

Table 10

Means and Standard Deviations for COMPASS Math Subtest Scores of Developmental Students and Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Compass Score	Yes	3,931	81.73	31.305	.499
	No	4,584	92.21	33.260	.491

Hypothesis 1a. There will be no significant difference between COMPASS math subtest scores of male developmental math students and male non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent;

3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in COMPASS math subtest scores for male developmental students versus male non-developmental students. A significant difference was found, $F(1, 3{,}199) = 85.406$, $p < .001$. The mean COMPASS math subtest score for male developmental students was 84.58 (±31.33) and the mean COMPASS math subtest score for male non-developmental students was 95.55 (±35.43). Hypothesis 1a was rejected. In other words, there was a marked difference between the COMPASS math scores of male developmental students and the COMPASS math scores of male non-developmental students. The male non-developmental students scored higher on the COMPASS math subtest than the male developmental students. Table 11 shows the results of the ANOVA test (Welch's Robust test) and Table 12 shows the descriptive statistics.

Table 11

Results from ANOVA (Welch's Robust) Test Comparing COMPASS Math Subtest Scores of Male Developmental Students to Male Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	85.406	1	3056.230	.000

a. Gender = Males
b. Asymptotically F distributed.

Table 12

Means and Standard Deviations for COMPASS Math Subtest Scores of Male Developmental Students and Male Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Compass Score	Yes	1,333	84.58	31.330	.858
	No	1,868	95.55	35.425	.820

a. Gender = Males

Hypothesis 1b. There will be no significant difference between COMPASS math subtest scores of female developmental math students and female non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .509 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in COMPASS math subtest scores for female developmental students versus female non-developmental students. A significant difference was found, $F(1, 5{,}312) = 125.807$, $p < .001$. The mean COMPASS math subtest score for female developmental students was 80.26 (±31.20) and the mean COMPASS math subtest score for female non-developmental students was 89.91 (±31.49). Hypothesis 1b was rejected. Table 13 shows the results of the ANOVA test and Table 14 shows the descriptive statistics. The female non-developmental students scored higher on the COMPASS math subtest than the female developmental students.

Table 13

Results from ANOVA Comparing COMPASS Math Subtest Scores of Female Developmental Students to Female Non-Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	123609.238	1	123609.238	125.807	.000
Within Groups	5219204.007	5312	982.531		
Total	5342813.244	5313			

a. Gender = Females

Table 14

Means and Standard Deviations for COMPASS Math Subtest Scores of Female Developmental Students and Female Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	2,598	80.26	31.196	.612
No	2,716	89.91	31.487	.604
Total	5,314	85.20	31.711	.435

Hypothesis 1c. There will be no significant difference between COMPASS math subtest scores of White developmental math students and White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .133 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in COMPASS math subtest scores for White developmental students versus White non-developmental students. A significant difference was found, $F(1, 6{,}541) = 134.035$, $p < .001$. The mean COMPASS math subtest score for White developmental students was 82.75 (±30.87) and the mean COMPASS math subtest score for White non-developmental students was 91.81 (±32.12). Hypothesis 1c was rejected. This means that there was a significant difference between the COMPASS math scores of White developmental students and the COMPASS math scores of White non-developmental students. The White non-developmental students scored higher on the COMPASS math subtest than the White developmental students. Table 15 shows the results of the ANOVA and Table 16 shows the descriptive statistics.

Table 15

Results from ANOVA Test Comparing COMPASS Math Subtest Scores of White Developmental Students to White Non-Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	133413.707	1	133413.707	134.035	.000
Within Groups	6510658.651	6,541	995.361		
Total	6644072.358	6,542			

a. Race = White

Table 16

Means and Standard Deviations for COMPASS Math Subtest Scores of White Developmental Students and White Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Compass Score	Yes	3,020	82.75	30.872	.562
	No	3,523	91.81	32.119	.541

a. Race = White

Hypothesis 1d. There will be no significant difference between COMPASS math subtest scores of non-White developmental math students and non-White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in COMPASS math subtest scores for non-White developmental students versus non-White non-developmental students. A significant difference was found, $F(1, 1{,}804) = 84.247$, $p < .001$. The mean COMPASS math subtest score for non-White developmental students was 77.96 (±32.68) and the mean COMPASS math subtest score for non-White non-developmental students was 92.98 (±36.86). Hypothesis 1c was rejected. In other words, there was a significant difference between the COMPASS math scores when comparing the non-White developmental students with the non-White non-developmental students. The non-White non-developmental students scored higher on the COMPASS math subtest than the non-White developmental students. Table 17 shows the results of the ANOVA test (Welch's Robust test) and Table 18 shows the descriptive statistics.

Table 17

Results from ANOVA (Welch's Robust) Test Comparing COMPASS Math Subtest Scores of Non-White Developmental Students to Non-White Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	84.247	1	1803.842	.000

a. Race = Non-White
b. Asymptotically F distributed.

Table 18

Means and Standard Deviations for COMPASS Math Subtest Scores of Non-White Developmental Students and Non-White Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Compass Score	Yes	853	77.96	32.682	1.119
	No	953	92.98	36.859	1.194

a. Race = Non-White

Part Two: ACT Math Subtest Scores

An ANOVA test was attempted for the research question and the sub-questions in this category. For those that resulted in a violation of the homogeneity of variance assumption, Welch's Robust test table was analyzed instead of the ANOVA table. One outlier was removed for the ACT data set. The score from the raw data was 40 on the math portion of the ACT. Since this value is higher than the maximum score, it was assumed that this was a transcription error by the participating institution. Students are not required to take the ACT test upon being admitted to the participating institution. Therefore not all students had a record in this category.

Hypothesis 2. There will be no significant difference between ACT math subtest scores of developmental math students and non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in ACT math subtest scores for developmental students versus non-developmental students. A significant difference was found, $F(1, 1{,}715) = 20.976$, $p < .001$. The mean ACT math subtest score for developmental students was 19.03 (±3.03) and the mean ACT math subtest score for non-developmental students was 19.70 (±2.71). Hypothesis 2 was rejected. This means that there was a marked difference between the ACT math scores when comparing the developmental students to the non-developmental students. The non-developmental students scored higher on the ACT math subtest than the developmental students. Table 19 shows the results of the ANOVA test (Welch's Robust test) and Table 20 shows the descriptive statistics.

Table 19

Results from ANOVA (Welch's Robust) Test Comparing ACT Math Subtest Scores of Developmental Students to Non-Developmental Students

	Statistic[a]	df1	df2	Sig.
Welch	20.976	1	1149.989	.000

a. Asymptotically F distributed.

Table 20

Means and Standard Deviations for ACT Math Subtest Scores of Developmental Students and Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
ACT Score	Yes	612	19.03	3.026	.122
	No	1,105	19.70	2.713	.082

Hypothesis 2a. There will be no significant difference between ACT math subtest scores of male developmental math students and male non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately

normally distributed; and 5) the Levene statistic is $p = .367 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in ACT math subtest scores for male developmental students versus male non-developmental students. A significant difference was found, $F(1, 664) = 23.410$, $p < .001$. The mean ACT math subtest score for male developmental students was 18.87 (±2.86) and the mean ACT math subtest score for male non-developmental students was 20.02 (±2.88). Hypothesis 2a was rejected. In other words, there was a strong difference between the ACT math scores of male developmental students when compared to ACT math scores of male non-developmental students. The male non-developmental students scored higher on the ACT math subtest than the male developmental students. Table 21 shows the results of the ANOVA test and Table 22 shows the descriptive statistics.

Table 21

Results from ANOVA Comparing ACT Math Subtest Scores of Male Developmental Students to Male Non-Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	193.518	1	193.518	23.410	.000
Within Groups	5489.052	664	8.267		
Total	5682.571	665			

a. Gender = Males

Table 22

Means and Standard Deviations for ACT Math Subtest Scores of Male Developmental Students and Male Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	213	18.87	2.862	.196
No	453	20.02	2.881	.135
Total	666	19.65	2.923	.113

Hypothesis 2b. There will be no significant difference between ACT math subtest scores of female developmental math students and female non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in ACT math subtest scores for female developmental students versus female non-developmental students. No significant difference was found, $F(1, 1{,}049) = 3.850$, $p = .05$. The mean ACT math subtest score for female developmental students was 19.11 (±3.11) and the mean ACT math subtest score for female non-developmental students was 19.47 (±2.57). Hypothesis 2b was not rejected. In other words, the ACT math scores were approximately the same when comparing the female developmental students to the female non-developmental students. Table 23 shows the results of the ANOVA test (Welch's Robust test) and Table 24 shows the descriptive statistics.

Table 23

Results from ANOVA (Welch's Robust) Test Comparing ACT Math Subtest Scores of Female Developmental Students to Female Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	3.850	1	722.374	.050

a. Gender = Females
b. Asymptotically F distributed.

Table 24

Means and Standard Deviations for ACT Math Subtest Scores of Female Developmental Students and Female Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
ACT Score	Yes	399	19.11	3.110	.156
	No	652	19.47	2.567	.101

a. Gender = Females

Hypothesis 2c. There will be no significant difference between ACT math subtest scores of White developmental math students and White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in ACT math subtest scores for White developmental students versus White non-developmental students. A significant difference was found, $F(1, 1{,}421) = 23.608$, $p < .001$. The mean ACT math subtest score for White developmental students was 19.02 (±3.04) and the mean ACT math subtest score for White non-developmental students was 19.81 (±2.69).

Hypothesis 2c was rejected. This means that there was a significant difference between the ACT math scores of White developmental students and the ACT math scores of White non-developmental students. The White non-developmental students had a higher ACT math subtest score than the White developmental math students. Table 25 shows the results of the ANOVA test (Welch's Robust test) and Table 26 shows the descriptive statistics.

Table 25

Results from ANOVA (Welch's Robust) Test Comparing ACT Math Subtest Scores of White Developmental Students to White Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	23.608	1	897.903	.000

a. Race = White
b. Asymptotically F distributed.

Table 26

Means and Standard Deviations for ACT Math Subtest Scores of White Developmental Students and White Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
ACT Score	Yes	491	19.02	3.041	.137
	No	932	19.81	2.694	.088

a. Race = White

Hypothesis 2d. There will be no significant difference between ACT math subtest scores of non-White developmental math students and non-White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .938 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in ACT math subtest scores for non-White developmental students versus non-White non-developmental students. No significant difference was found, $F(1, 266) = .002$, $p = .968$. The mean ACT math subtest score for non-White developmental students was 19.12 (±2.97) and the mean ACT math subtest score for non-White non-developmental students was 19.11 (±2.79). Hypothesis 2d was not rejected. In other words, the non-White developmental students scored approximately the same as the non-White non-developmental students on the ACT math test. Table 27 shows the results of the ANOVA test and Table 28 shows the descriptive statistics.

Table 27

Results from ANOVA Comparing ACT Math Subtest Scores of Non-White Developmental Students to Non-White Non-Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.013	1	.013	.002	.968
Within Groups	2187.401	266	8.223		
Total	2187.414	267			

a. Race = Non-White

Table 28

Means and Standard Deviations for ACT Math Subtest Scores of Non-White Developmental Students and Non-White Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	113	19.12	2.967	.279
No	155	19.11	2.793	.224
Total	268	19.12	2.862	.175

Part Three: Age

An ANOVA test was attempted for analyzing this research question and its sub-questions. When the violation of homogeneity of variance was violated, Welch's Robust test table was analyzed rather than the ANOVA table. All cases in the population were used in this analysis (with the exception with the 189 entries that did not answer or responded "Unknown" to the race component of enrollment data collection).

Hypothesis 3. There will be no significant difference in age of developmental math students and non-developmental students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in age for developmental students versus non-developmental students. A significant difference was found, $F(1, 10{,}001) = 421.398$, $p < .001$. The mean age for developmental students was 25.8 (±8.65) and the mean age for non-developmental students was 22.6 (±6.41). Hypothesis 3 was rejected. This means that there was a significant difference between the ages of the developmental students when compared to the ages of non-developmental students. The developmental students, on average, were older than the non-developmental students. Table 29 shows the results of the ANOVA test (Welch's Robust test) and Table 30 shows the descriptive statistics.

Table 29

Results from ANOVA (Welch's Robust) Test Comparing Age of Developmental Students to Non-Developmental Students

	Statistic[a]	df1	df2	Sig.
Welch	421.398	1	8484.811	.000

a. Asymptotically F distributed.

Table 30

Means and Standard Deviations for Age of Developmental Students and Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Age	Yes	4,656	25.77	8.647	.127
	No	5,347	22.60	6.411	.088

Hypothesis 3a. There will be no significant difference in age of male developmental math students and male non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in age for male developmental students versus male non-developmental students. A significant difference was found, $F(1, 3{,}758) = 80.345$, $p < .001$. The mean age for male developmental students was 24.5 (±7.52) and the mean age for male non-developmental students was 22.4 (±6.23). Hypothesis 3a was rejected. In other words, there was a significant difference when the ages of male developmental students were compared with the ages of male non-developmental students. The male developmental students, on average, were older than the male non-developmental students. Table 31 shows the results of the ANOVA test (Welch's Robust test) and Table 32 shows the descriptive statistics.

Table 31

Results from ANOVA (Welch's Robust) Test Comparing Age of Male Developmental Students to Male Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	80.345	1	2983.850	.000

a. Gender = Males

b. Asymptotically F distributed.

Table 32

Means and Standard Deviations for Age of Male Developmental Students and Male Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Age	Yes	1,572	24.50	7.516	.190
	No	2,188	22.42	6.233	.133

a. Gender = Males

Hypothesis 3b. There will be no significant difference in age of female developmental math students and female non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in age for female developmental students versus female non-developmental students. A significant difference was found, $F(1, 6{,}241) = 336.069$, $p < .001$. The mean age for female developmental students was 26.4 (±9.10) and the mean age for female non-developmental students was 22.7 (±6.53). Hypothesis 3b was rejected. In other words, there was a significant difference when comparing the female developmental group to the female non-developmental group regarding age. The female developmental students, on average, were older than the female non-developmental students. Table 33 shows the results of the ANOVA test (Welch's Robust test) and Table 34 shows the descriptive statistics.

Table 33

Results from ANOVA (Welch's Robust) Test Comparing Age of Female Developmental Students to Female Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	336.069	1	5582.447	.000

a. Gender = Females
b. Asymptotically F distributed.

Table 34

Means and Standard Deviations for Age of Female Developmental Students and Female Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Age	Yes	3,084	26.42	9.103	.164
	No	3,159	22.73	6.528	.116

a. Gender = Females

Hypothesis 3c. There will be no significant difference in age of White developmental math students and White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test) was used to determine if there was a difference in age for White developmental students versus White non-developmental students. A significant difference was found, $F(1, 7{,}697) = 348.269$, $p < .001$. The mean age for White developmental students was 25.6 (±8.64) and the mean age for White non-developmental students was 22.4 (±6.35). Hypothesis 3c was rejected. This means that the mean age of the White developmental group was significantly different from the mean age of the White non-developmental group. The White developmental students, on average, were older than the White non-developmental students. Table 35 shows the results of the ANOVA test (Welch's Robust test) and Table 36 shows the descriptive statistics.

Table 35

Results from ANOVA (Welch's Robust) Test Comparing Age of White Developmental Students to White Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	348.269	1	6452.716	.000

a. Race = White
b. Asymptotically F distributed.

Table 36

Means and Standard Deviations for Age of White Developmental Students and White Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Age	Yes	3,566	25.64	8.639	.145
	No	4,133	22.37	6.349	.099

a. Race = White

Hypothesis 3d. There will be no significant difference in age of non-White developmental math students and non-White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) was used to determine if there was a difference in age for non-White developmental students versus non-White non-developmental students. A significant difference was found, $F(1, 2{,}113) = 66.186$, $p < .001$. The mean age for non-White developmental students was 26.3 (±8.73) and the mean age for non-White non-developmental students was 23.6 (±6.68). Hypothesis 3d was rejected. In other words, there was a significant difference between the ages of the non-White developmental students compared to the ages of the non-White non-developmental students. The non-White developmental students, on average, were older than the non-White non-developmental students. Table 37 shows the results of the ANOVA test (Welch's Robust test) and Table 38 shows the descriptive statistics.

Table 37

Results from ANOVA (Welch's Robust) Test Comparing Age of Non-White Developmental Students to Non-White Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	66.186	1	1912.784	.000

a. Race = Non-White
b. Asymptotically F distributed.

Table 38

Means and Standard Deviations for Age of Non-White Developmental Students and Non-White Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Age	Yes	1,024	26.33	8.733	.273
	No	1,091	23.57	6.675	.202

a. Race = Non-White

Part Four: Pass/Fail Status in MTH 100

A Chi-square test for association was used for all parts of the first research question and its sub-questions. From the sample, six cases were removed. There were three students that enrolled in MTH 100 during the study time period as “audit” and three that were recorded as “withdraw passing.”

Hypothesis 4. There will be no significant difference between the developmental math students and non-developmental math students in regards to passing the first college-level math course. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found no significant difference between the developmental students and non-developmental students in regards to passing MTH 100, $\chi^2(1) = .339$, $p = .561$. No significant difference was found based on the difference in observed versus expected proportions. The expected number of developmental students to pass MTH 100 was 3,373 and the actual number was 3,386 (73%). The expected number of developmental students to fail MTH 100 was 1,280 and the actual number was 1,267 (27%). The expected number of non-developmental students to pass MTH 100 was 3,874 and the actual number was 3,861

(72%). The expected number of non-developmental students to fail MTH 100 was 1,470 and the actual number was 1,483 (28%). Hypothesis 4 was not rejected. This means that there was no significant difference between the pass/fail status of developmental math students and the pass/fail status of non-developmental math students in MTH 100 (i.e., actual numbers were as expected). Tables 39 and 40 show the results of the Chi-square test. Figure 2 illustrates the two groups.

Table 39

Results from Chi-square Test Comparing Pass/Fail Status in MTH 100 for Developmental Math Students and Non-Developmental Math Students

Passed MTH 100 "C" or Better		TOOK_DEV N	TOOK_DEV Y	Total
Fail	Count	1,483$_a$	1,267$_a$	2,750
	Expected Count	1,470	1,280	2,750
	% within Passed MTH 100 "C" or Better	53.9	46.1	100
	% within TOOK_DEV	27.8	27.2	27.5
	% of Total	14.8	12.7	27.5
	Residual	13.0	-13.0	
	Std. Residual	.3	-.4	
Pass	Count	3,861$_a$	3,386$_a$	7,247
	Expected Count	3,874	3,373	7,247
	% within Passed MTH 100 "C" or Better	53.3	46.7	100
	% within TOOK_DEV	72.2	72.8	72.5
	% of Total	38.6	33.9	72.5
	Residual	-13.0	13.0	
	Std. Residual	-.2	.2	
Total	Count	5,344	4,653	9,997
	Expected Count	5,344	4,653	9,997
	% within Passed MTH 100 "C" or Better	53.5	46.5	100
	% within TOOK_DEV	100.0	100.0	100
	% of Total	53.5	46.5	100

Each subscript letter denotes a subset of TOOK_DEV categories whose column proportions do not differ significantly from each other at the .05 level.

Table 40

Chi-square Tests Comparing Pass/Fail Status in MTH 100 for Developmental Math Students and Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	.339[a]	1	.561
Continuity Correction	.313	1	.576
Likelihood Ratio	.339	1	.561
N of Valid Cases	9,997		

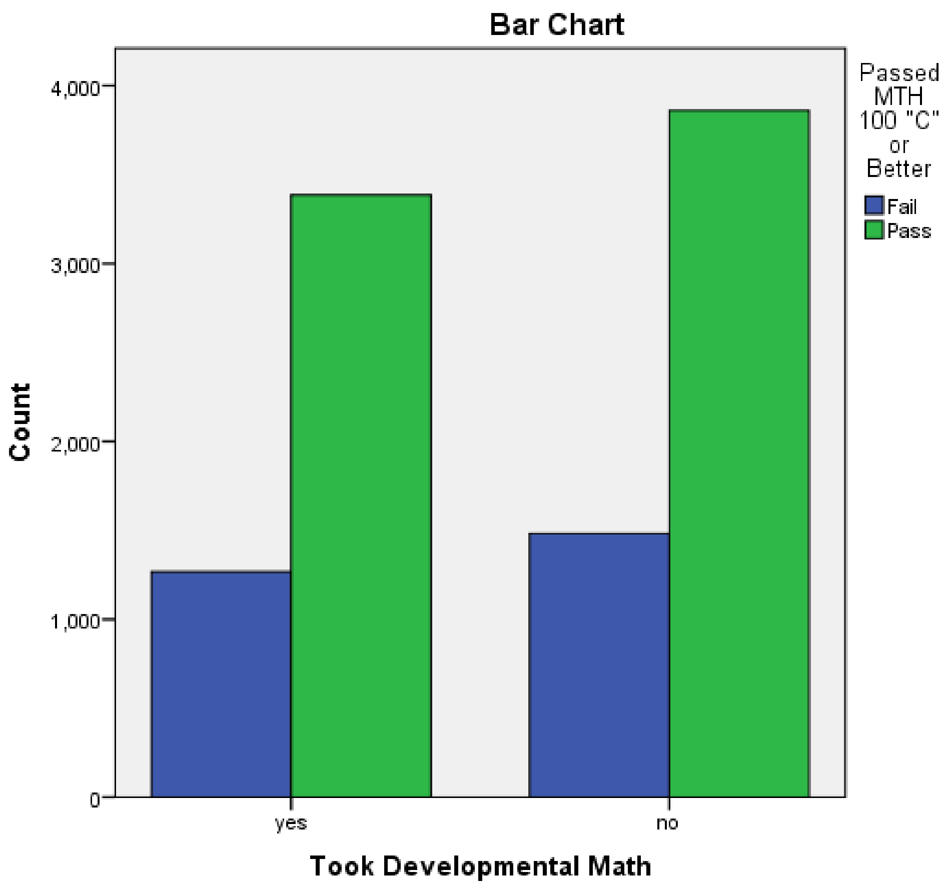

Figure 2. Chi-square test comparing pass/fail status in MTH 100 for developmental math students and non-developmental math students

Hypothesis 4a. There will be no significant difference between the male developmental math students and male non-developmental math students in regards to passing the first college-level math course. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found no significant difference between the male developmental students and male non-developmental students in regards to passing MTH 100, $\chi^2(1) = 1.236$, $p = .266$. No significant difference was found based on the difference in observed versus expected proportions. The expected number of male developmental students to pass MTH 100 was 1,057 and the actual number was 1,073 (68%). The expected number of male developmental students to fail MTH 100 was 514 and the actual number was 498 (32%). The expected number of male non-developmental students to pass MTH 100 was 1,472 and the actual number was 1,456 (67%). The expected number of male non-developmental students to fail MTH 100 was 715 and the actual number was 731 (33%). Hypothesis 4a was not rejected. In other words, there was no significant difference between the pass/fail status of male developmental math students and the pass/fail status of male non-developmental math students in MTH 100. Tables 41 and 42 show the results of the Chi-square test. Figure 3 illustrates the two groups.

Table 41

Results from Chi-square Test Comparing Pass/Fail Status in MTH 100 for Male Developmental Math Students and Male Non-Developmental Math Students

Passed MTH 100 "C" or Better		TOOK_DEV		Total
		N	Y	
Fail	Count	731_a	498_a	1,229
	Expected Count	715.2	513.8	1,229
	% within Passed MTH 100 "C" or Better	59.5	40.5	100
	% within TOOK_DEV	33.4	31.7	32.7
	% of Total	19.5	13.3	32.7
	Residual	15.8	-15.8	
	Std. Residual	.6	-.7	
Pass	Count	$1,456_a$	$1,073_a$	2,529
	Expected Count	1,471.8	1,057.2	2,529
	% within Passed MTH 100 "C" or Better	57.6%	42.4	100
	% within TOOK_DEV	66.6%	68.3	67.3
	% of Total	38.7%	28.6	67.3
	Residual	-15.8	15.8	
	Std. Residual	-.4	.5	
Total	Count	2,187	1,571	3,758
	Expected Count	2,187	1,571	3,758
	% within Passed MTH 100 "C" or Better	58.2	41.8	100
	% within TOOK_DEV	100	100	100
	% of Total	58.2	41.8	100

Each subscript letter denotes a subset of TOOK_DEV categories whose column proportions do not differ significantly from each other at the .05 level.

Table 42

Chi-square Tests Comparing Pass/Fail Status in MTH 100 for Male Developmental Math Students and Male Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	1.236^b	1	.266
Continuity Correction	1.159	1	.282
Likelihood Ratio	1.238	1	.266
N of Valid Cases	3,758		

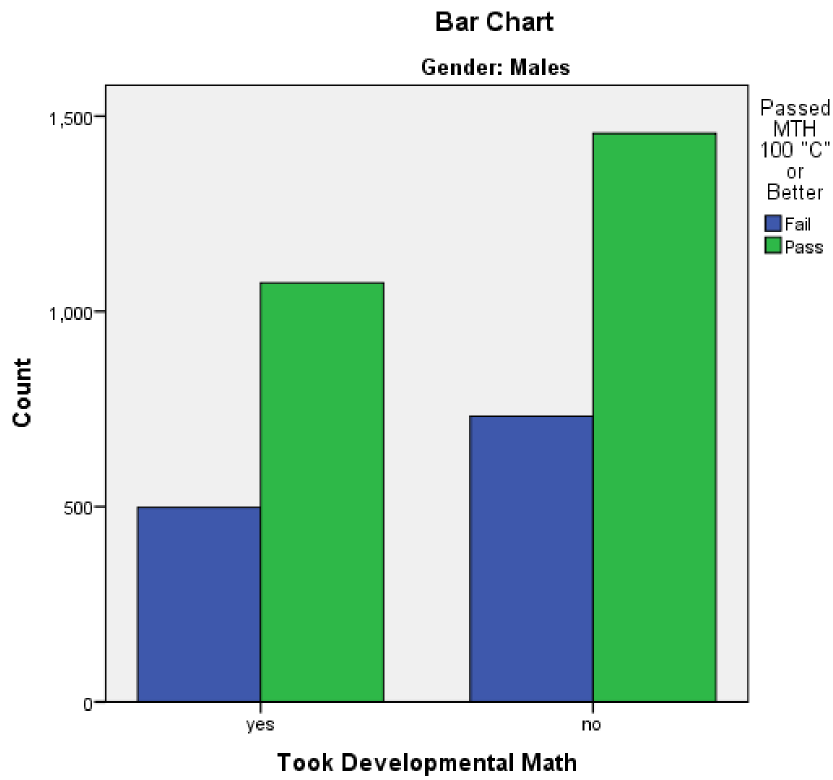

Figure 3. Chi-square tests comparing pass/fail status in MTH 100 for male developmental math students and male non-developmental math students

Hypothesis 4b. There will be no significant difference between the female developmental math students and female non-developmental math students in regards to passing the first college-level math course. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found no significant difference between the female developmental students and female non-developmental students in regards to passing MTH 100, $\chi^2(1) = 1.083$, $p = .298$. No significant difference was found based on the difference in observed versus expected proportions. The expected number of female developmental students to pass MTH 100 was 2,231 and the actual number was 2,313 (75%). The expected number of female developmental students to fail MTH 100 was 751 and the actual number was 769 (25%). The expected number of female non-developmental students to pass MTH 100 was 2,388 and the actual number was 2,405 (76%). The expected number of female non-developmental students to fail MTH 100 was 770 and the actual number was 752 (24%). Hypothesis 4b was not rejected. This means that there was no significant difference between the pass/fail status of female developmental math students and the pass/fail status of female non-developmental math students in MTH 100. Tables 43 and 44 show the results of the Chi-square test. Figure 4 illustrates the two groups.

Table 43

Results from Chi-square Test Comparing Pass/Fail Status in MTH 100 for Female Developmental Math Students and Female Non-Developmental Math Students

Passed MTH 100 "C" or Better		TOOK_DEV		Total
		N	Y	
Fail	Count	752_a	769_a	1,521
	Expected Count	769.6	751.4	1,521
	% within Passed MTH 100 "C" or Better	49.4	50.6	100
	% within TOOK_DEV	23.8	25	24.4
	% of Total	12.1	12.3	24.4
	Residual	-17.6	17.6	
	Std. Residual	-.6	.6	
Pass	Count	2405_a	$2,313_a$	4,718
	Expected Count	2,387.4	2,330.6	4,718
	% within Passed MTH 100 "C" or Better	51.0	49.0	100
	% within TOOK_DEV	76.2	75.0	75.6
	% of Total	38.5	37.1	75.6
	Residual	17.6	-17.6	
	Std. Residual	.4	-.4	
Total	Count	3,157	3,082	6,239
	Expected Count	3,157	3,082	6,239
	% within Passed MTH 100 "C" or Better	50.6	49.4	100
	% within TOOK_DEV	100	100	100
	% of Total	50.6	49.4	100

Each subscript letter denotes a subset of TOOK_DEV categories whose column proportions do not differ significantly from each other at the .05 level.

Table 44

Chi-square Tests Comparing Pass/Fail Status in MTH 100 for Female Developmental Math Students and Female Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	1.083[b]	1	.298
Continuity Correction	1.022	1	.312
Likelihood Ratio	1.082	1	.298
N of Valid Cases	6,239		

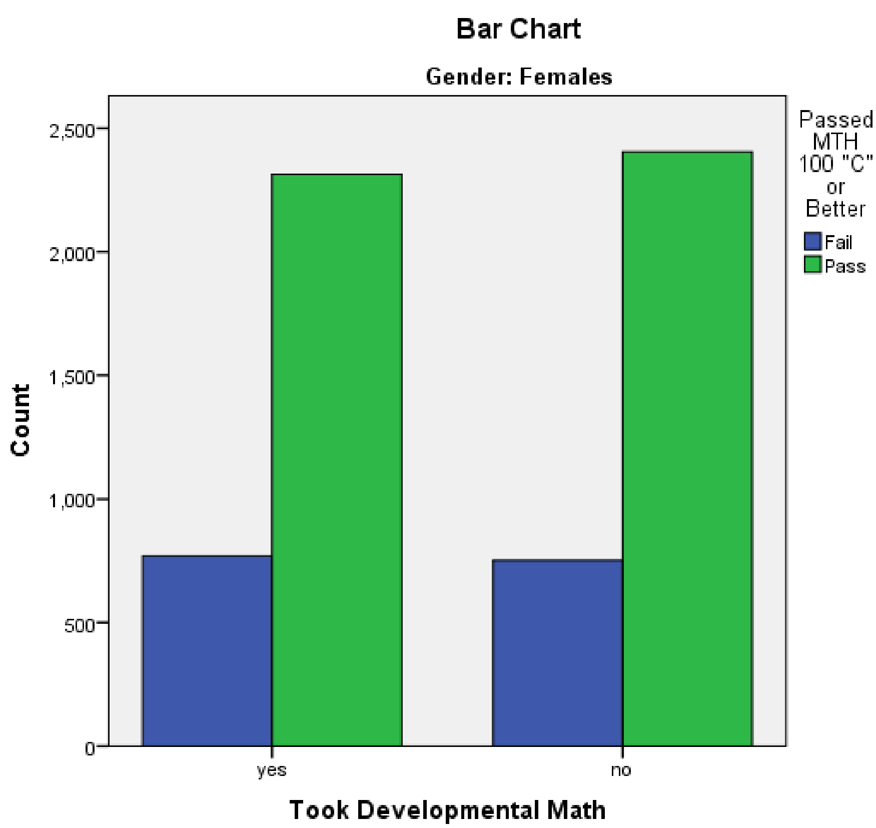

Figure 4. Chi-square tests comparing pass/fail status in MTH 100 for female developmental math students and female non-developmental math students

Hypothesis 4c. There will be no significant difference between the White developmental math students and White non-developmental math students in regards to passing the first college-level math course. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found no significant difference between the White developmental students and White non-developmental students in regards to passing MTH 100, $\chi^2(1) = .104$, $p = .747$. No significant difference was found based on the difference in observed versus expected proportions. The expected number of White developmental students to pass MTH 100 was 2,656 and the actual number was 2,650 (74%). The expected number of White developmental students to fail MTH 100 was 907 and the actual number was 913 (26%). The expected number of White non-developmental students to pass MTH 100 was 3,079 and the actual number was 3,085 (75%). The expected number of White non-developmental students to fail MTH 100 was 1,051 and the actual number was 1,045 (25%). Hypothesis 4c was not rejected. In other words, roughly the same number of developmental and non-developmental White students passed/failed MTH 100. Tables 45 and 46 show the results of the Chi-square test. Figure 5 illustrates the two groups.

Table 45

Results from Chi-square Test Comparing Pass/Fail Status in MTH 100 for White Developmental Math Students and White Non-Developmental Math Students

Passed MTH 100 "C" or Better		TOOK_DEV N	TOOK_DEV Y	Total
Fail	Count	$1,045_a$	913_a	1,958
	Expected Count	1,051.2	906.8	1,958
	% within Passed MTH 100 "C" or Better	53.4	46.6	100
	% within TOOK_DEV	25.3	25.6	25.5
	% of Total	13.6	11.9	25.5
	Residual	-6.2	6.2	
	Std. Residual	-.2	.2	
Pass	Count	$3,085_a$	$2,650_a$	5,735
	Expected Count	3,078.8	2,656.2	5,735
	% within Passed MTH 100 "C" or Better	53.8	46.2	100
	% within TOOK_DEV	74.7	74.4	74.5
	% of Total	40.1	34.4	74.5
	Residual	6.2	-6.2	
	Std. Residual	.1	-.1	
Total	Count	4,130	3,563	7,693
	Expected Count	4,130	3,563	7,693
	% within Passed MTH 100 "C" or Better	53.7	46.3	100
	% within TOOK_DEV	100	100	100
	% of Total	53.7	46.3	100

Each subscript letter denotes a subset of TOOK_DEV categories whose column proportions do not differ significantly from each other at the .05 level.

Table 46

Chi-square Tests Comparing Pass/Fail Status in MTH 100 for White Developmental Math Students and White Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	.104[b]	1	.747
Continuity Correction	.088	1	.767
Likelihood Ratio	.104	1	.747
N of Valid Cases	7,693		

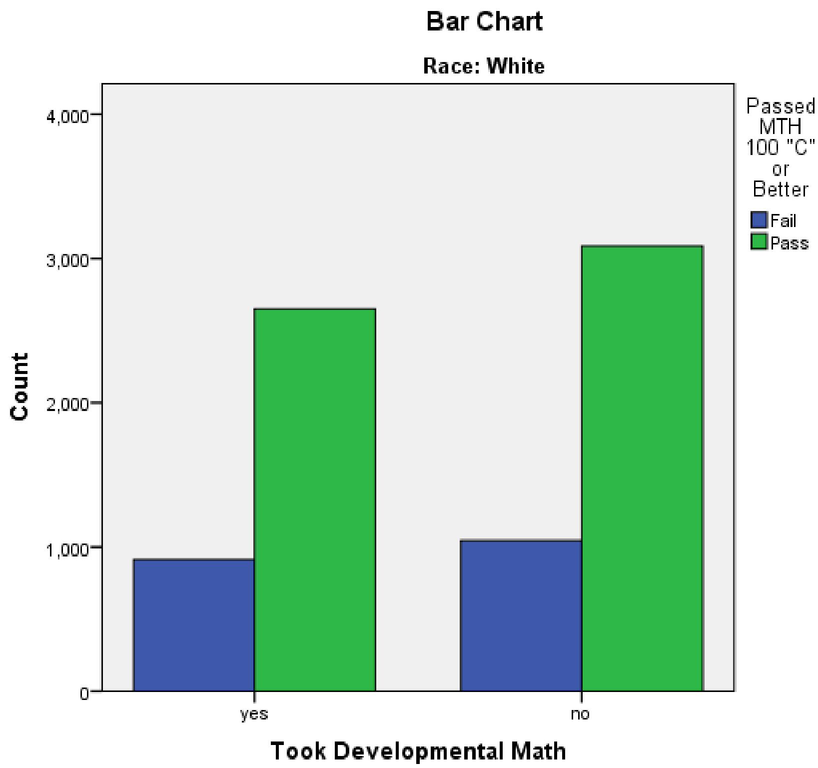

Figure 5. Chi-square tests comparing pass/fail status in MTH 100 for white developmental math students and white non-developmental math students

Hypothesis 4d. There will be no significant difference between the non-White developmental math students and non-White non-developmental math students in regards to passing the first college-level math course. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found a significant difference between the non-White developmental students and non-White non-developmental students in regards to passing MTH 100, $\chi^2(1) = 4.148$, $p = .042$. A significant difference was found based on the difference in observed versus expected proportions. The expected number of non-White developmental students to pass MTH 100 was 667 and the actual number was 689 (67%). The expected number of non-White developmental students to fail MTH 100 was 357 and the actual number was 335 (33%). The expected number of non-White non-developmental students to pass MTH 100 was 710 and the actual number was 688 (63%). The expected number of non-White non-developmental students to fail MTH 100 was 381 and the actual number was 403 (37%). Hypothesis 4d was rejected. The analysis showed that non-White developmental students failed less often than non-White non-developmental students. Tables 47 and 48 show the results of the Chi-square test. Figure 6 illustrates the two groups.

Table 47

Results from Chi-square Test Comparing Pass/Fail Status in MTH 100 for Non-White Developmental Math Students and Non-White Non-Developmental Math Students

Passed MTH 100 "C" or Better		TOOK_DEV		Total
		N	Y	
Fail	Count	403_a	335_b	738
	Expected Count	380.7	357.3	738
	% within Passed MTH 100 "C" or Better	54.6	45.4	100
	% within TOOK_DEV	36.9	32.7	34.9
	% of Total	19.1	15.8	34.9
	Residual	22.3	-22.3	
	Std. Residual	1.1	-1.2	
Pass	Count	688_a	689_b	1,377
	Expected Count	710.3	666.7	1,377
	% within Passed MTH 100 "C" or Better	50.0	50.0	100
	% within TOOK_DEV	63.1	67.3	65.1
	% of Total	32.5	32.6	65.1
	Residual	-22.3	22.3	
	Std. Residual	-.8	.9	
Total	Count	1,091	1024	2,115
	Expected Count	1,091	1,024	2,115
	% within Passed MTH 100 "C" or Better	51.6	48.4	100
	% within TOOK_DEV	100.0	100.0	100
	% of Total	51.6	48.4	100

Each subscript letter denotes a subset of TOOK_DEV categories whose column proportions do not differ significantly from each other at the .05 level.

Table 48

Chi-square Tests Comparing Pass/Fail Status in MTH 100 for Non-White Developmental Math Students and Non-White Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	4.148[b]	1	.042
Continuity Correction	3.964	1	.046
Likelihood Ratio	4.152	1	.042
N of Valid Cases	2,115		

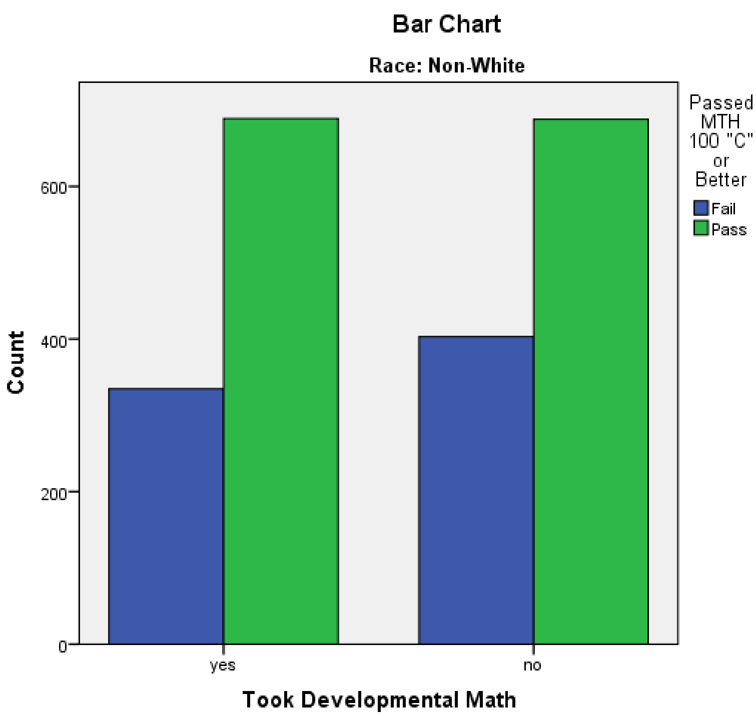

Figure 6. Chi-square tests comparing pass/fail status in MTH 100 for non-white developmental math students and non-white non-developmental math students

Part Five: Continuous Enrollment

An ANOVA test was used to analyze all but one of the research questions in this category. When the violation of homogeneity of variance was violated, Welch's Robust test table was analyzed rather than the ANOVA table. Sixteen cases from the sample were removed for this set of questions since 99.8% of the data recorded twenty-four semesters or less.

Hypothesis 5. There will be no significant difference between continuous enrollment of developmental math students and non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; 5) and the Levene statistic is $p = .027 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in continuous enrollment for developmental students versus non-developmental students. A significant difference was found, $F(1, 9{,}985) = 8.334$, $p = .004$. Therefore Hypothesis 5 was rejected. This means that there was a significant difference in the continuous enrollment of developmental students and the continuous enrollment of non-developmental students. The developmental group attended more semesters than the non-developmental group. Table 49 presents the ANOVA table and Table 50 provides the mean continuous enrollment of developmental math students, which was 6.53 (±3.80), and the mean continuous enrollment of non-developmental math students, which was 6.32 (±3.70).

Table 49

Results from ANOVA Comparing Continuous Enrollment of Developmental Students with Non-Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	117.230	1	117.230	8.334	.004
Within Groups	140456.110	9985	14.067		
Total	140573.340	9986			

Table 50

Means and Standard Deviations for Continuous Enrollment of Developmental Students and Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	4,646	6.53	3.804	.056
No	5,341	6.32	3.703	.051
Total	9,987	6.42	3.752	.038

Hypothesis 5a. There will be no significant difference between continuous enrollment of male students with developmental math status and male students with non-developmental math status. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and the Levene statistic is $p = .357 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in continuous enrollment for male developmental students versus male non-developmental students. No significant difference was found, $F(1, 3{,}748) = 2.956$, $p = .086$. Therefore Hypothesis 5a was not rejected. In other words, male developmental students attended roughly the same number of semesters as male non-developmental students. Table 51 presents the ANOVA table and Table 52 provides the mean continuous enrollment of male developmental math students, which was 6.41 (±3.73), and the mean continuous enrollment of male non-developmental math students, which was 6.20 (±3.67).

Table 51

Results from ANOVA Comparing Continuous Enrollment of Male Developmental Students with Non-Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	40.363	1	40.363	2.956	.086
Within Groups	51170.331	3748	13.653		
Total	51210.693	3749			

a. Gender = Males

Table 52

Means and Standard Deviations for Continuous Enrollment of Male Developmental Students and Male Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	1,567	6.41	3.725	.094
No	2,183	6.20	3.673	.079
Total	3,750	6.29	3.696	.060

Hypothesis 5b. There will be no significant difference between continuous enrollment of female students with developmental math status and female students with non-developmental math status. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples

were obtained is approximately normally distributed; and 5) the Levene statistic is p = .064 > .01, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in continuous enrollment for female developmental students versus female non-developmental students. A significant difference was found, $F(1, 6{,}235) = 4.313$, $p = .038$. Therefore Hypothesis 5b was rejected. This means that there was a significant difference in the number of semesters attended by developmental students compared to that of non-developmental students. The female students in the developmental group attended more semesters than the female students in the non-developmental group. Table 53 presents the ANOVA table and Table 54 provides the mean continuous enrollment of female developmental math students, which was 6.60 (±3.84), and the mean continuous enrollment of female non-developmental math students, which was 6.40 (±3.72).

Table 53

Results from ANOVA Comparing Continuous Enrollment of Female Developmental Students to Female Non- Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	61.702	1	61.702	4.313	.038
Within Groups	89195.509	6,235	14.306		
Total	89257.211	6,236			

a. Gender = Females

Table 54

Means and Standard Deviations for Continuous Enrollment of Female Developmental Students and Female Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	3,079	6.60	3.843	.069
No	3,158	6.40	3.722	.066
Total	6,237	6.50	3.783	.048

Hypothesis 5c. There will be no significant difference between continuous enrollment of White students with developmental math status and White students with non-developmental math status. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .243 > .01$, therefore the homogeneity of variance assumption was not violated.

An ANOVA test was used to determine if there was a difference in continuous enrollment for White developmental students versus White non-developmental students. A significant difference was found, $F(1, 7{,}685) = 4.628$, $p = .031$. Therefore Hypothesis 5c was rejected. In other words, there was a significant difference in the number of semesters attended by White developmental students and that of White non-developmental students. The White students in the developmental group attended more semesters than the White students in the non-developmental group. Table 55 presents the ANOVA table and Table 56 provides the mean continuous enrollment of White developmental math students, which was 6.50 (±3.76), and the mean continuous enrollment of White non-developmental math students, which was 6.32 (±3.70).

Table 55

Results from ANOVA Comparing Continuous Enrollment of White Developmental Students with White Non- Developmental Students

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	64.208	1	64.208	4.628	.031
Within Groups	106620.712	7,685	13.874		
Total	106684.920	7,686			

a. Race = White

Table 56

Means and Standard Deviations for Continuous Enrollment of White Developmental Students and White Non-Developmental Students

Dev Status	N	Mean	Std. Deviation	Std. Error
Yes	3,559	6.50	3.758	.063
No	4,128	6.32	3.696	.058
Total	7,687	6.40	3.726	.042

Hypothesis 5d. There will be no significant difference between continuous enrollment of non-White students with developmental math status and non-White students with non-developmental math status. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p = .009 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test) was used to determine if there was a difference in continuous enrollment for non-White developmental students versus non-White non-developmental students. No significant difference was found, $F(1, 2{,}109) = 2.248$, $p = .134$. The mean grade point average for developmental students was 6.68 (±4.01) and the mean grade point average for non-developmental students was 6.43 (±3.74). Hypothesis 5d was not rejected. In other words, the non-White developmental students attended approximately the same number of semesters as the non-White non-developmental students. Table 57 shows the results of the ANOVA test (Welch's Robust test) and Table 58 shows the descriptive statistics.

Table 57

Results from ANOVA (Welch's Robust) Test Comparing Continuous Enrollment of Non-White Developmental Students with Non- White Non- Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	2.248	1	2071.510	.134

a. Race = Non-White
b. Asymptotically F distributed.

Table 58

Means and Standard Deviations for Continuous Enrollment of Non-White Developmental Students Versus Non-White Non-Developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
Number of Terms	Yes	1,021	6.68	4.009	.125
Attended	No	1,090	6.43	3.740	.113

a. Race = Non-White

Part Six: College Grade Point Average

An ANOVA test was attempted for this research question and its sub-questions. When the assumption of homogeneity of variance was violated, Welch's Robust test table was analyzed rather than the ANOVA table. All students in the population were included in the analysis (with the exception of those students with missing or unknown race for the race sub-questions, which was 189 cases).

Hypothesis 6. There will be no significant difference between college grade point average of developmental math students and non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test) found a significant difference between the grade point averages of developmental students versus non-developmental students, $F(1, 10{,}001) = 52.999$, $p < .001$. The mean grade point average for developmental students was 2.84 (±0.75) and the mean grade point average for non-developmental students was 2.70 (±1.05). Hypothesis 6 was rejected. This means that there was a significant difference between the grade point average of developmental students and the grade point average of non-developmental students. From the analysis, the developmental students had a higher grade point average than the non-developmental students. Table 59 shows the results of the ANOVA test (Welch's Robust test) and Table 60 shows the descriptive statistics.

Table 59

Results from ANOVA test Comparing Cumulative Grade Point Average of Students with Developmental Status to Students with Non-Developmental Status

	Statistic[a]	df1	df2	Sig.
Welch	52.999	1	9665.846	.000

a. Asymptotically F distributed.

Table 60

Means and Standard Deviations for College Grade Point Average of Developmental Students and Non-developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
GPA	Yes	4,656	2.8356	.75170	.01102
	No	53,47	2.7042	1.04537	.01430

Hypothesis 6a. There will be no significant difference between college grade point average of male developmental math students and male non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) found a significant difference between the grade point averages of male developmental students versus male non-developmental students, $F(1, 3{,}758) = 28.079$, $p < .001$. The mean grade point average for male developmental students was 2.74 (±0.785) and the mean grade point average for male non-developmental students was 2.58 (±1.083). Hypothesis 6a was rejected. In other words, there was a significant difference between the grade point average of male developmental students and the grade point average of male non-developmental students. The male developmental students had a higher grade point average than the male non-developmental students. Table 61 shows the results of the ANOVA (Welch's Robust) test and Table 62 shows the descriptive statistics.

Table 61

Results from ANOVA test Comparing Cumulative Grade Point Average of Male Developmental Students with Male Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	28.079	1	3757.713	.000

a. Gender = Males
b. Asymptotically F distributed.

Table 62

Means and Standard Deviations for College Grade Point Average of Male Developmental Students and Male Non-developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
GPA	Yes	1,572	2.7404	.78492	.01980
	No	2,188	2.5789	1.08297	.02315

a. Gender = Males

Hypothesis 6b. There will be no significant difference between college grade point average of female developmental math students and female non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) found a significant difference between the grade point averages of female developmental students versus female non-developmental students, $F(1, 6{,}241) = 17.531$, $p < .001$. The mean grade point average for female developmental students was 2.88 (±0.730) and the mean grade point average for female non-developmental students was 2.79 (±1.010). Hypothesis 6b was rejected. This means that there was a significant difference between the grade point average of female developmental students and the grade point average of female non-developmental students. The female developmental students had a higher grade point average than the female non-developmental students. Table 63 shows the results of the ANOVA (Welch's Robust) test and Table 64 shows the descriptive statistics.

Table 63

Results from ANOVA Test Comparing Cumulative Grade Point Average of Female Developmental Students with Female Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	17.531	1	5753.557	.000

a. Gender = Females
b. Asymptotically F distributed.

Table 64

Means and Standard Deviations for College Grade Point Average of Female Developmental Students and Female Non-developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
GPA	Yes	3,084	2.8841	.72955	.01314
	No	3,159	2.7909	1.00962	.01796

a. Gender = Females

Hypothesis 6c. There will be no significant difference between college grade point average of White developmental math students and White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) found a significant difference between the grade point averages of White developmental students versus White non-developmental students, $F(1, 7{,}697) = 34.810$, $p < .001$. The mean grade point average for White developmental students was 2.91 (±0.727) and the mean grade point average for White non-developmental students was 2.80 (±0.996). Hypothesis 6c was rejected. In other words, there was a significant difference between the grade point average of White developmental students and the grade point average of White non-developmental students. The White developmental students had a higher grade point average than the White non-developmental students. Table 65 shows the results of the ANOVA (Welch's Robust) test and Table 66 shows the descriptive statistics.

Table 65

Results from ANOVA Test Comparing Cumulative Grade Point Average of White Developmental Students with White Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	34.810	1	7495.976	.000

a. Race = White
b. Asymptotically F distributed.

Table 66

Means and Standard Deviations for College Grade Point Average of White Developmental Students and White Non-developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
GPA	Yes	3,566	2.9119	.72679	.01217
	No	4,133	2.7957	.99624	.01550

a. Race = White

Hypothesis 6d. There will be no significant difference between college grade point average of non-White developmental math students and non-White non-developmental math students. The assumptions are as follows: 1) the observations are random; 2) the observations are independent; 3) the data are metric; 4) the population from which the samples were obtained is approximately normally distributed; and 5) the Levene statistic is $p < .001 < .01$, therefore the homogeneity of variance assumption was violated.

An ANOVA test (Welch's Robust test table) found a significant difference between the grade point averages of non-White developmental students versus non-White non-developmental students, $F(1, 2{,}113) = 25.414$, $p < .001$. The mean grade point average for non-White developmental students was 2.58 (±0.768) and the mean grade point average for non-White non-developmental students was 2.37 (±1.147). Hypothesis 6d was rejected. This means that there was a significant difference between the grade point average of non-White developmental students and the grade point average of non-White non-developmental students. The non-White developmental students had a higher grade point average than the non-White non-developmental students. Table 67 shows the results of the ANOVA (Welch's Robust) test and Table 68 shows the descriptive statistics.

Table 67

Results from ANOVA Test Comparing Cumulative Grade Point Average of Non-White Developmental Students with Non-White Non-Developmental Students

	Statistic[b]	df1	df2	Sig.
Welch	25.414	1	1914.552	.000

a. Race = Non-White
b. Asymptotically F distributed.

Table 68

Means and Standard Deviations for College Grade Point Average of Non-White Developmental Students and Non-White Non-developmental Students

	Developmental Math	N	Mean	Std. Deviation	Std. Error Mean
GPA	Yes	1,024	2.5783	.76804	.02400
	No	1,091	2.3655	1.14707	.03473

a. Race = Non-White

Part Seven: Graduation Status

A Chi-square test of association was used for all research questions in this category. From the sample, there were 252 cases where students had multiple graduation records. In other words, there were 252 times when students earned more than one degree or certificate (some had up to four records). All duplicates were removed by keeping the first graduation on record. Therefore it is possible for the results to be lower than actual numbers if credentials were earned by the students in the study after summer 2013.

Hypothesis 7. There will be no significant difference between graduation status of developmental math students and non-developmental math students. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found a significant difference between the graduation status of developmental students and the graduation status of non-developmental students, $\chi^2(1) = 24.401$, $p < .001$. A significant difference was found based on the difference in observed versus expected proportions. The expected number of developmental students to graduate was 1,160 and the actual number was 1,266 (28%). The expected number of developmental students to not graduate was 3,430 and the actual number was 3,324 (72%). The expected number of non-developmental students to graduate was 1,320 and the actual number was 1,214 (23%). The expected number of non-developmental students to not graduate was 3,904 and the actual number was 4,010 (77%). Hypothesis 7 was rejected. This means that there was a marked difference between the two groups. The standardized residual for the developmental students that graduated was 3.1, which is significant, and there were more in this group than expected. The standardized residual for the non-developmental students that graduated was -2.9, which is significant, and there were fewer in this group than expected. Of those that did not graduate, more did not take developmental mathematics. Or, in stating the converse, of those that did graduate, more did take developmental mathematics. Tables 69 and 70 show the results of the Chi-square test. Figure 7 illustrates the two groups.

Table 69

Results from Chi-square Test Comparing Graduation Status for Developmental Math Students and Non-Developmental Math Students

Took Developmental Math		Graduated Yes=1; No=0		
		0	1	Total
Yes	Count	3,324	1,266	4,590
	Expected Count	3,430.1	1,159.9	4,590
	% within Took Developmental Math	72.4	27.6	100
	% within Graduated	45.3	51.0	46.8
	% of Total	33.9	12.9	46.8
	Residual	-106.1	106.1	
	Std. Residual	-1.8	3.1	
No	Count	4,010	1,214	5,224
	Expected Count	3,903.9	1,320.1	5,224
	% within Took Developmental Math	76.8	23.2	100
	% within Graduated	54.7	49	53.2
	% of Total	40.9	12.4	53.2
	Residual	106.1	-106.1	
	Std. Residual	1.7	-2.9	
Total	Count	7,334	2,480	9,814
	Expected Count	7334	2480	9,814
	% within Took Developmental Math	74.7	25.3	100
	% within Graduated	100	100	100
	% of Total	74.7	25.3	100

Table 70

Chi-square Tests Comparing Graduation Status for Developmental Math Students and Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	24.401	1	.000
Continuity Correction	24.172	1	.000
Likelihood Ratio	24.365	1	.000
N of Valid Cases	9,814		

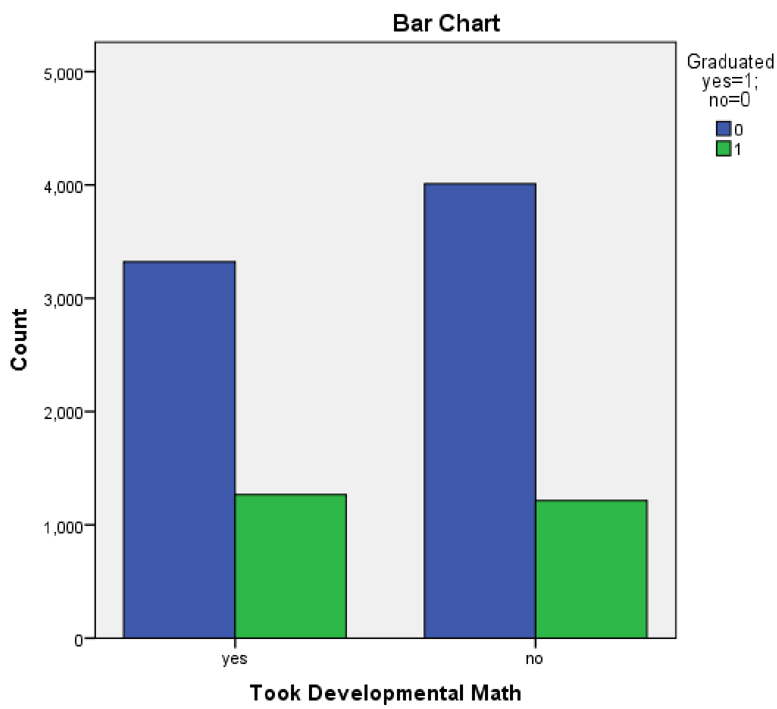

Figure 7. Chi-square tests comparing graduation status for developmental math students and non-developmental math students

Hypothesis 7a. There will be no significant difference between the graduation status of male developmental math students and the graduation status of male non-developmental math students. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found no significant difference between the male developmental students and male non-developmental students in regards to graduation status, $\chi^2(1) = .652$, $p = .419$. No significant difference was found based on the difference in observed versus expected proportions. The expected number of male developmental students to graduate was 337 and the actual number was 347 (22%). The expected number of male developmental students to not graduate was 1,235 and the actual number was 1,225 (78%). The expected number of male non-developmental students to graduate was 469 and the actual number was 459 (21%). The expected number of male non-developmental students to not graduate was 1,719 and the actual number was 1,729 (79%). Hypothesis 7a was not rejected. This means that there was no difference between the graduation status of male developmental students and the graduation status of male non-developmental students. Tables 71 and 72 show the results of the Chi-square test. Figure 8 illustrates the two groups.

Table 71

Results from Chi-square Test Comparing Graduation Status for Male Developmental Math Students and Male Non-Developmental Math Students

		Graduated Yes=1; No=0		
Took Developmental Math		0	1	Total
Yes	Count	1,225	347	1,572
	Expected Count	1,235	337	1,572
	% within Took Developmental Math	77.9	22.1	100
	% within Graduated	41.5	43.1	41.8
	% of Total	32.6	9.2	41.8
	Residual	-10	10	
	Std. Residual	-.3	.5	
No	Count	1,729	459	2,188
	Expected Count	1,719	469	2,188
	% within Took Developmental Math	79	21	100
	% within Graduated	58.5	56.9	58.2
	% of Total	46	12.2	58.2
	Residual	10	-10	
	Std. Residual	.2	-.5	
Total	Count	2,954	806	3,760
	Expected Count	2,954	806	3,760
	% within Took Developmental Math	78.6	21.4	100
	% within Graduated	100	100	100
	% of Total	78.6	21.4	100

Table 72

Chi-square Tests Comparing Graduation Status for Male Developmental Math Students and Male Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	.652	1	.419
Continuity Correction	.589	1	.443
Likelihood Ratio	.651	1	.420
N of Valid Cases	3,760		

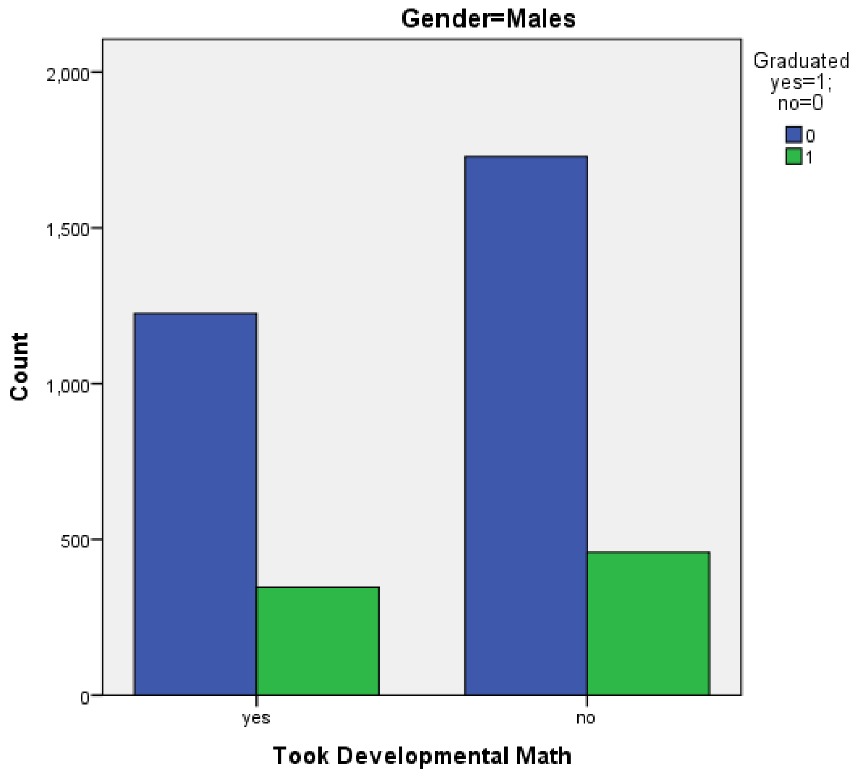

Figure 8. Chi-square Tests Comparing Graduation Status for Male Developmental Math Students and Male Non-Developmental Math Students

Hypothesis 7b. There will be no significant difference between the graduation status of female developmental math students and the graduation status of female non-developmental math students. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found a significant difference between the graduation status of female developmental students and the graduation status of female non-developmental students, $\chi^2(1) = 27.143$, $p < .001$. A significant difference was found based on the difference in observed versus expected proportions. The expected number of female developmental students to graduate was 844 and the actual number was 936 (30%). The expected number of female developmental students to not graduate was 2,240 and the actual number was 2,148 (70%). The expected number of female non-developmental students to graduate was 865 and the actual number was 773 (25%). The expected number of female non-developmental students to not graduate was 2,294 and the actual number was 2,386 (75%). Hypothesis 7b was rejected. In other words, there was a difference between the graduation status of female developmental students and the graduation status of female non-developmental students. The standardized residual for the female developmental students that did graduate was 3.2, which is significant, and there were more in this group than expected. The standardized residual for the female non-developmental students that graduated was -3.1, which is significant, and there were fewer in this group than expected. Of the female students that did not graduate, more did not take developmental mathematics. Stating the converse, the analysis showed that of the female students that did graduate, more did take developmental mathematics. Tables 73 and 74 show the results of the Chi-square test. Figure 9 illustrates the two groups.

Table 73

Results from Chi-square Test Comparing Graduation Status for Female Developmental Math Students and Female Non-Developmental Math Students

Gender: Female			Graduated Yes=1; No=0 0	1	Total
Took Developmental Math	Yes	Count	2,148	936	3,084
		Expected Count	2,239.8	844.2	3,084
		% within Took Developmental Math	69.6	30.4	100
		% within Graduated	47.4%	54.8	49.4
		% of Total	34.4%	15.0	49
		Residual	-91.8	91.8	
		Std. Residual	-1.9	3.2	
	No	Count	2,386	773	3,159
		Expected Count	2,294.2	864.8	3,159
		% within Took Developmental Math	75.5	24.5	100
		% within Graduated	52.6	45.2	50.6
		% of Total	38.2	12.4	50.6
		Residual	91.8	-91.8	
		Std. Residual	1.9	-3.1	
Total		Count	4,534	1,709	6,243
		Expected Count	4,534	1,709	6,243
		% within Took Developmental Math	72.6	27.4	100
		% within Graduated	100	100	100
		% of Total	72.6	27.4	100

Table 74

Chi-square Tests Comparing Graduation Status for Female Developmental Math Students and Female Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	27.143	1	.000
Continuity Correction	26.848	1	.000
Likelihood Ratio	27.168	1	.000
N of Valid Cases	6,243		

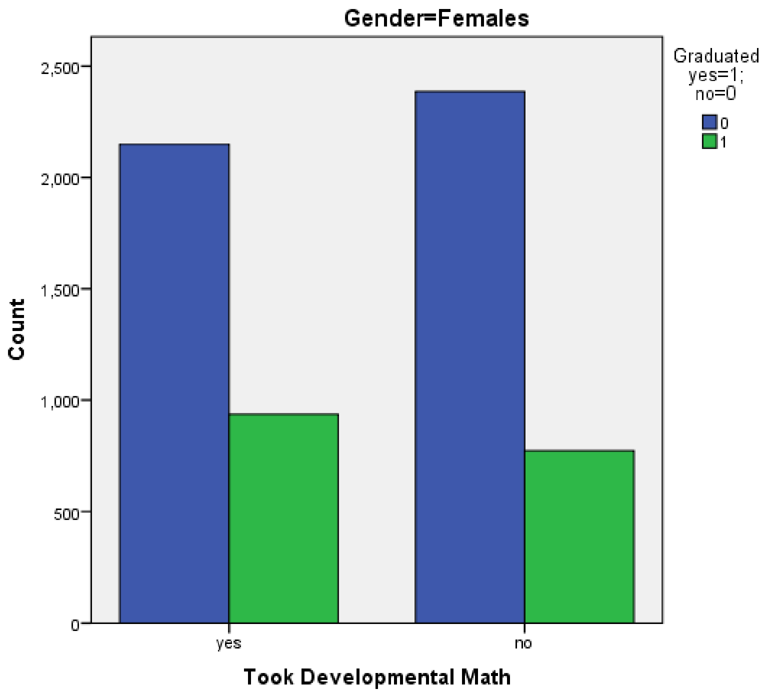

Figure 9. Chi-square Tests Comparing Graduation Status for Female Developmental Math Students and Female Non-Developmental Math Students

Hypothesis 7c. There will be no significant difference between the graduation status of White developmental math students and the graduation status of White non-developmental math students. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found a significant difference between the graduation status of White developmental students and the graduation status of White non-developmental students, $\chi^2(1) = 12.377$, $p < .001$. A significant difference was found based on the difference in observed versus expected proportions. The expected number of White developmental students to graduate was 869 and the actual number was 935 (26%). The expected number of White developmental students to not graduate was 2,697 and the actual number was 2,631 (74%). The expected number of White non-developmental students to graduate was 1,007 and the actual number was 941 (23%). The expected number of White non-developmental students to not graduate was 3,126 and the actual number was 3,192 (77%). Hypothesis 7c was rejected. This means that there was a significant difference between the graduation status of White developmental students and the graduation status of White non-developmental students. The standardized residual for the White developmental students that graduated was 2.2, which is significant, and there were more in this group than expected. Of the White students that did not graduate, more did not take developmental mathematics. Tables 75 and 76 show the results of the Chi-square test. Figure 10 illustrates the two groups.

Table 75

Results from Chi-square Test Comparing Graduation Status for White Developmental Math Students and White Non-Developmental Math Students

			Graduated Yes=1; No=0		
Race: White			0	1	Total
Took Developmental Math	Yes	Count	2,631	935	3,566
		Expected Count	2,697.1	868.9	3,566
		% within Took Developmental Math	73.8	26.2	100
		% within Graduated	45.2	49.8	46.3
		% of Total	34.2	12.1	46.3
		Residual	-66.1	66.1	
		Std. Residual	-1.3	2.2	
	No	Count	3,192	941	4,133
		Expected Count	3,125.9	1,007.1	4,133
		% within Took Developmental Math	77.2	22.8	100.
		% within Graduated	54.8	50.2	53.7
		% of Total	41.5	12.2	53.7
		Residual	66.1	-66.1	
		Std. Residual	1.2	-2.1	
Total		Count	5,823	1,876	7,699
		Expected Count	5,823	1,876	7,699
		% within Took Developmental Math	75.6	24.4	100
		% within Graduated	100	100	100
		% of Total	75.6	24.4	100

Table 76

Chi-square Tests Comparing Graduation Status for White Developmental Math Students and White Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	12.377	1	.000
Continuity Correction	12.190	1	.000
Likelihood Ratio	12.356	1	.000
N of Valid Cases	7,699		

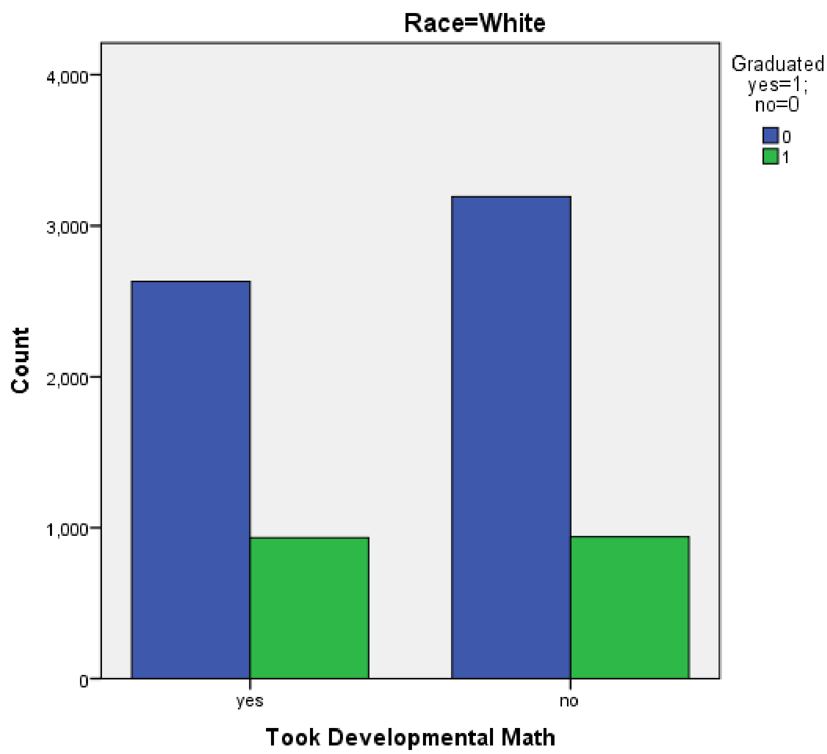

Figure 10. Chi-square Tests Comparing Graduation Status for White Developmental Math Students and White Non-Developmental Math Students

Hypothesis 7d. There will be no significant difference between the graduation status of non-White developmental math students and the graduation status of non-White non-developmental math students. The assumptions are as follows: 1) data are categorical; 2) the two variables form two categorical, independent groups; and 3) no cell has an expected frequency less than five.

A Chi-square test for association found a significant difference between the graduation status of non-White developmental students and the graduation status non-White non-developmental students, $\chi^2(1) = 13.802$, $p < .001$. A significant difference was found based on the difference in observed versus expected proportions. The expected number of non-White developmental students to graduate was 292 and the actual number was 331 (32%). The expected number of non-White developmental students to not graduate was 732 and the actual number was 693 (68%). The expected number of non-White non-developmental students to graduate was 312 and the actual number was 273 (25%). The expected number of non-White non-developmental students to not graduate was 779 and the actual number was 818 (75%). Hypothesis 7d was rejected. In other words, there was a significant difference between the graduation status of non-White developmental students and the graduation status of non-White non-developmental students. The standardized residual for non-White developmental students that graduated was 2.3, which is significant, and there were more in this group than expected. Of the non-White students that did not graduate, more did not take developmental mathematics. Conversely, of the non-White students that did graduate, more did take developmental mathematics. Tables 77 and 78 show the results of the Chi-square test. Figure 11 illustrates the two groups.

Table 77

Results from Chi-square Test Comparing Graduation Status for Non-White Developmental Math Students and Non-White Non-Developmental Math Students

Race: Non-White			Graduated Yes=1; No=0 0	1	Total
Took Developmental Math	Yes	Count	693	331	1,024
		Expected Count	731.6	292.4	1,024
		% within Took Developmental Math	67.7	32.3	100
		% within Graduated	45.9	54.8	48.4
		% of Total	32.8	15.7	48.4
		Residual	-38.6	38.6	
		Std. Residual	-1.4	2.3	
	No	Count	818	273	1,091
		Expected Count	779.4	311.6	1,091
		% within Took Developmental Math	75	25.	100
		% within Graduated	54.1	45.2	51.6
		% of Total	38.7	12.9	51.6
		Residual	38.6	-38.6	
		Std. Residual	1.4	-2.2	
Total		Count	1511	604	2,115
		Expected Count	1511	604	2,115
		% within Took Developmental Math	71.4	28.6	100
		% within Graduated	100	100	100
		% of Total	71.4	28.6	100

Table 78

Chi-square Tests Comparing Graduation Status for Non-White Developmental Math Students and Non-White Non-Developmental Math Students

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	13.802	1	.000
Continuity Correction	13.446	1	.000
Likelihood Ratio	13.808	1	.000
N of Valid Cases	2,115		

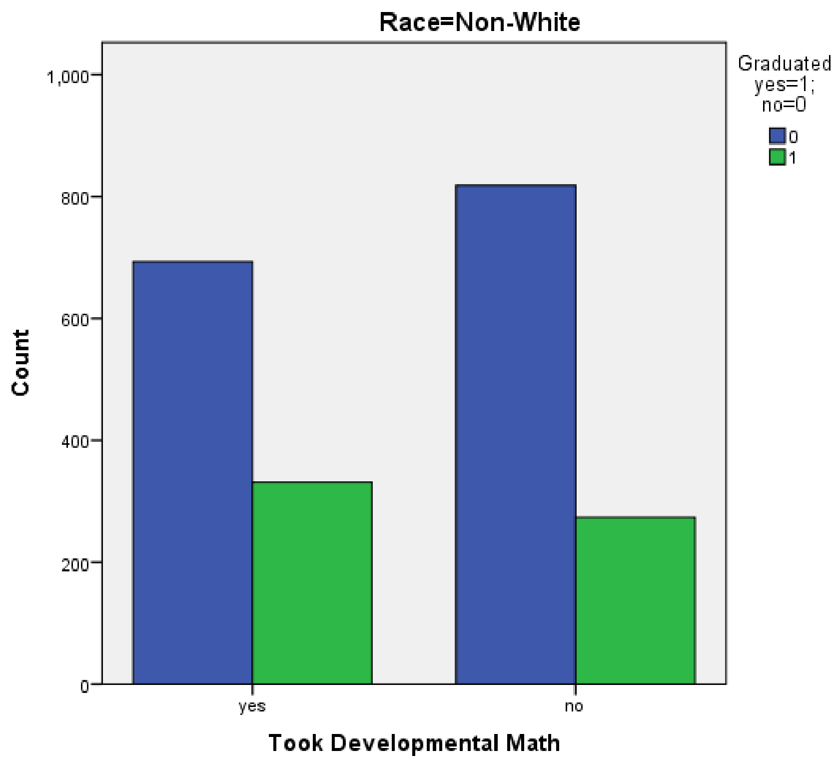

Figure 11. Chi-square Tests Comparing Graduation Status for Non-White Developmental Math Students and Non-White Non-Developmental Math Students

Part Eight: Interaction Effects on Pass/Fail Status in MTH 100

The existence of interaction effects among students in the study and pass/fail status in MTH 100 are discussed below. There were six cases removed where students enrolled in the class as audit status (three) or withdrew passing (three). The assumptions are as follows: 1) the dependent variable is dichotomous; 2) there are one or more independent variables that are either continuous or categorical; 3) observations are independent, mutually exclusive, and exhaustive; and 4) there needs to be a linear relationship between any independent variables and the dependent variable. However, the Hosmer and Lemeshow Test tests the null hypothesis that there is a linear relationship between the predictor variables and the log odds of the criterion. A significant Chi-square ($p < .001$) means the data do not fit the model. To minimize Type I errors due to the violation of this assumption, a confidence level of .01 will be used for analyzing this section.

A logistic regression analysis was performed to predict the effects of gender, race, and developmental status on the likelihood that a student would pass MTH 100. The logistic regression model was statistically significant, $\chi^2(3) = 157.937$, $p < .001$. The model explained 2.3% (Nagelkerke R^2) of the variance in pass/fail status in MTH 100 and correctly classified 72.5% of the cases. Perhaps the low percentage (2.3%) can be explained by the fact that the linearity assumption was violated. Gender and race had significant partial effects ($p < .001$ for each). Females were 1.529 times more likely to pass MTH 100 than males. White students were 1.604 times more likely to pass MTH 100 than non-White students. Non-developmental students were 0.998 times more likely to pass MTH 100 than developmental students. The logistic regression equation was

$\ln(ODDS) = .352 + .424(GENDER) + .473(RACE) - .002(DEV\_STATUS)$. Table 79 shows the classification table and Table 80 shows the logistic regression coefficient, Wald test, significance, and odds ratio for each of the predictors.

Table 79
Classification Table of Logistic Regression Analysis for Pass/Fail Status in MTH 100 and Gender, Race, and Developmental Status

Classification Table[a]

			Predicted		
			Passed MTH 100 "C" or Better		Percentage Correct
	Observed		Fail	Pass	
Step 1	Passed MTH 100 "C" or Better	Fail	0	2696	.0
		Pass	0	7112	100.0
	Overall Percentage				72.5

a. The cut value is .500

Table 80

Logistic Regression Predicting Pass/Fail Status from Gender, Race, and Developmental Status

		B	Wald	Sig.	Exp(B)
Step 1[a]	Gender(1)	.424	83.417	.000	1.529
	Race(1)	.473	79.770	.000	1.604
	Dev Status(1)	-.002	.002	.963	.998
	Constant	.352	34.064	.000	1.422

a. Variable(s) entered on step 1: Gender, Race, Dev Status.

Part Nine: Interaction Effects on Continuous Enrollment

The existence of interaction effects among students in the study and continuous enrollment are discussed below. Since 99.8% of the students enrolled in at most twenty-three semesters during the study period, cases with more than this number of terms were removed from this set of research questions. The assumptions are as follows: 1) the dependent variable is continuous; 2) the independent variables consist of two or more categorical, independent groups; 3) observations are independent; 4) there are no significant outliers; 5) the dependent variable is approximately normally distributed; and there is homogeneity of variance ($p = .070 > .01$)

A two-way ANOVA was conducted that examined the effect of gender and developmental status as well as race and developmental status on continuous enrollment. There was no statistically significant interaction between the effects of gender and developmental status on continuous enrollment, $F(1, 9810) = .038$, $p = .846$. There was no significant interaction between the effects of race and developmental status on continuous enrollment, $F(1, 9810) = .310$, $p = .578$. Since there was no significant interaction, the main effects were analyzed. The main effect of race was not significant ($p = .101$). The main effect of gender was not significant ($p = .067$). The main effect of developmental status was significant ($p = .011$). Table 81 and Table 82 show the two-way ANOVA results, and Figures 12 and 13 show the estimated marginal means.

Table 81

ANOVA Results for Gender and Developmental Status on Continuous Enrollment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	168.540[a]	3	56.180	3.762	.010
Intercept	377182.321	1	377182.321	25258.784	.000
Dev Status	95.426	1	95.426	6.390	.011
Gender	50.115	1	50.115	3.356	.067
Dev Status * Gender	.562	1	.562	.038	.846
Error	146489.972	9810	14.933		
Total	557448.000	9814			
Corrected Total	146658.512	9813			

Table 82

ANOVA Results for Race and Developmental Status on Continuous Enrollment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	162.204[a]	3	54.068	3.621	.013
Intercept	281642.485	1	281642.485	18859.948	.000
Dev Status	101.816	1	101.816	6.818	.009
Race	40.192	1	40.192	2.691	.101
Dev Status * Race	4.625	1	4.625	.310	.578
Error	146496.308	9810	14.933		
Total	557448.000	9814			
Corrected Total	146658.512	9813			

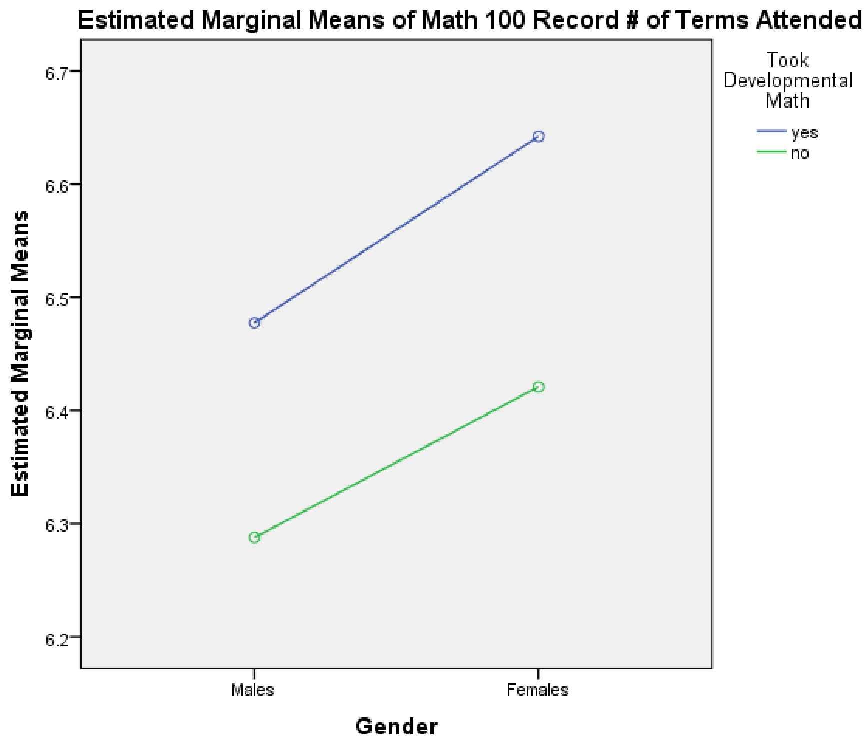

Figure 12. Plot of Means for Gender and Developmental Status on Continuous Enrollment

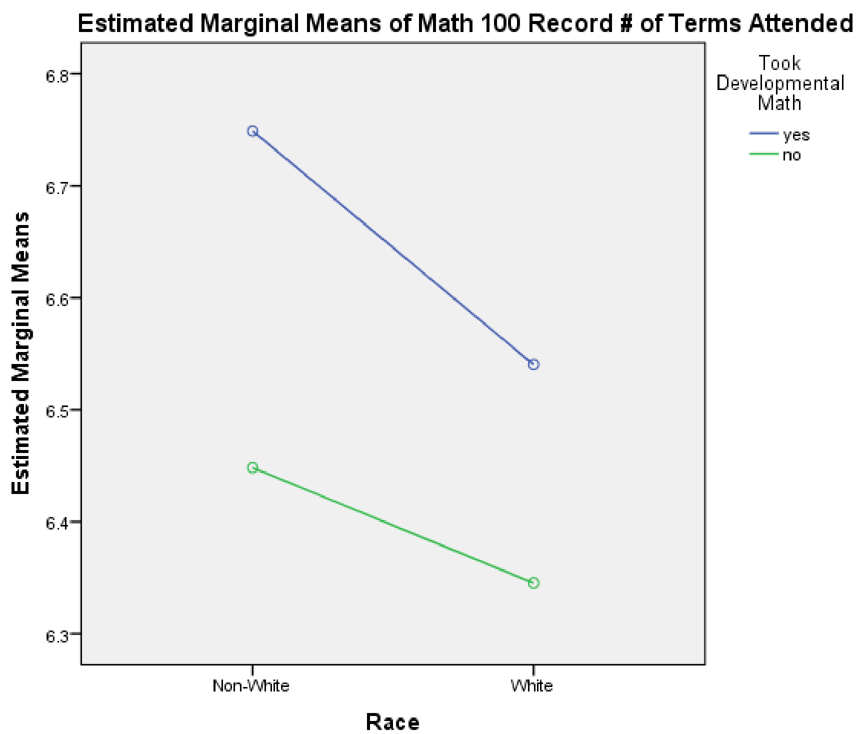

Figure 13. Plot of Means for Race and Developmental Status on Continuous Enrollment

Part Ten: Interaction Effects on Grade Point Average

The existence of interaction effects among students in the study and grade point average are discussed below. The assumptions are as follows: 1) the dependent variable is continuous; 2) the independent variables consist of two or more categorical, independent groups; 3) observations are independent; 4) there are no significant outliers; 5) the dependent variable is approximately normally distributed; and 6) there is no homogeneity of variance ($p < .01$), so a 99% confidence level ($p = .01$) will be used in order to minimize Type I errors.

A two-way ANOVA was conducted that examined the effect of gender and developmental status as well as race and developmental status on grade point average. There was no statistically significant interaction between the effects of gender and developmental status on grade point average, $F(1, 9810) = 3.448$, $p = .063$. There was no significant interaction between the effects of race and developmental status on grade point average, $F(1, 9810) = 4.720$, $p = .030$ at the .01 alpha level. Since there was no significant interaction, the main effects were analyzed. The main effect of race was significant ($p < .001$). The main effect of gender was significant ($p < .001$). The main effect of developmental status was significant ($p < .001$). Table 83 and Table 84 show the two-way ANOVA results, and Figures 14 and 15 show the estimated marginal means.

Table 83

ANOVA Results for Gender and Developmental Status on Grade Point Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	118.470[a]	3	39.490	47.279	.000
Intercept	68438.146	1	68438.146	81936.434	.000
Dev Status	37.159	1	37.159	44.488	.000
Gender	69.470	1	69.470	83.172	.000
Dev Status * Gender	2.880	1	2.880	3.448	.063
Error	8193.891	9810	.835		
Total	83474.603	9814			
Corrected Total	8312.361	9813			

Table 84

ANOVA Results for Race and Developmental Status on Grade Point Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	290.595[a]	3	96.865	118.459	.000
Intercept	46968.770	1	46968.770	57439.178	.000
Dev Status	44.830	1	44.830	54.823	.000
Race	241.477	1	241.477	295.308	.000
Dev Status * Race	3.860	1	3.860	4.720	.030
Error	8021.766	9,810	.818		
Total	83474.603	9,814			
Corrected Total	8312.361	9,813			

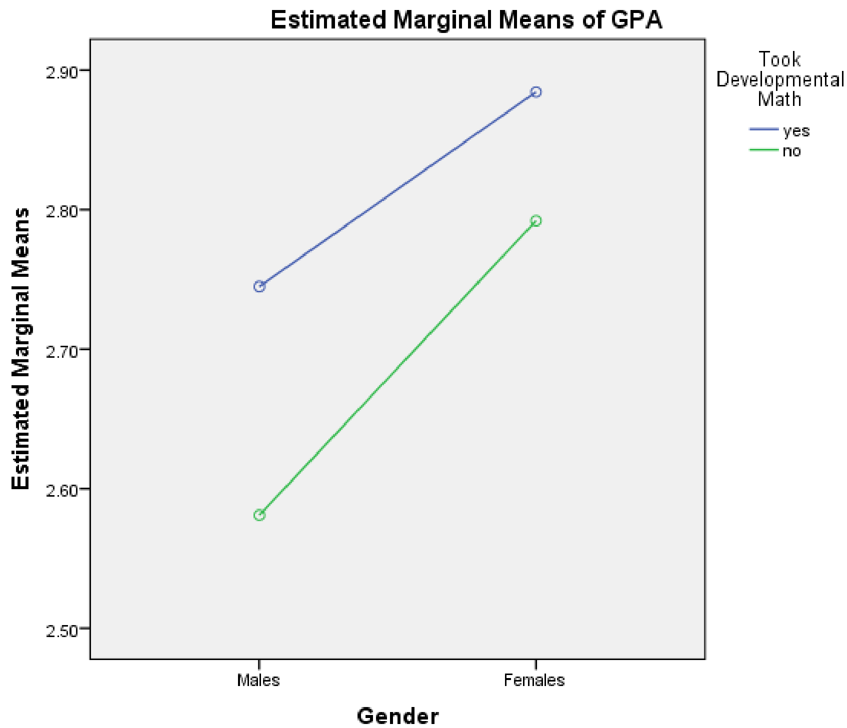

Figure 14. Plot of Means for Gender and Developmental Status on Grade Point Average

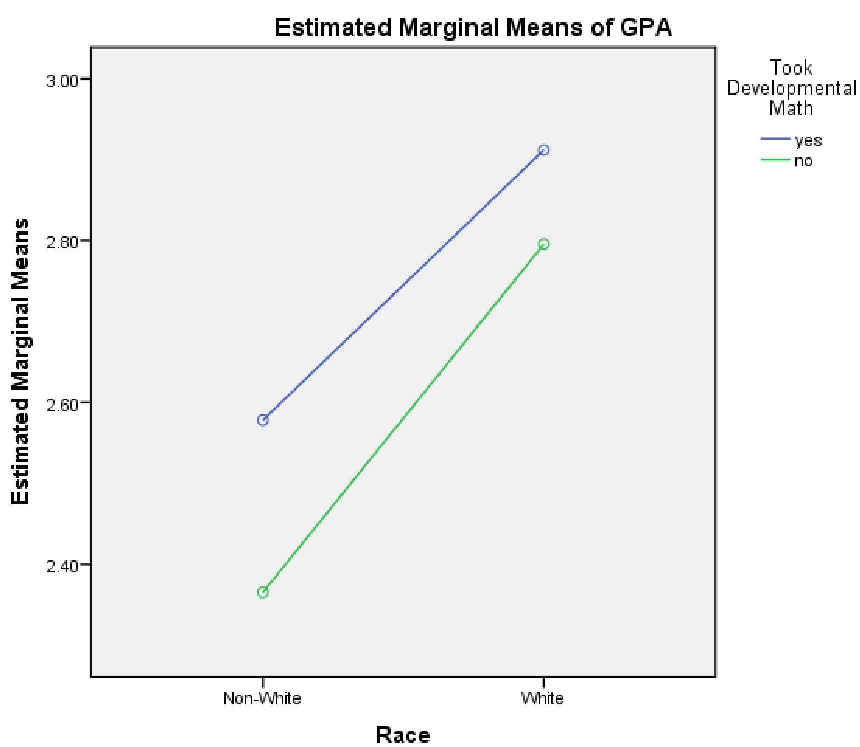

Figure 15. Plot of Means for Race and Developmental Status on Grade Point Average

Part Eleven: Interaction Effects on Graduation Status

The existence of interaction effects among students in the study and graduation status are discussed below. There were 252 duplicate cases where students earned more than one degree or certificate. Only one record (the first credential earned) was kept per student to include in the analysis. The assumptions are as follows: 1) the dependent variable is dichotomous; 2) there are one or more independent variables that are either continuous or categorical; 3) observations are independent, mutually exclusive, and exhaustive; and4) there was a linear relationship between the independent variables and the dependent variable. The Hosmer and Lemeshow Test tests the null hypothesis that there is a linear relationship between the predictor variables and the log odds of the criterion. A non-significant Chi-square (p = .248) means the data do fit the model.

A logistic regression analysis was performed to predict the effects of gender, race, and developmental status on the likelihood that a student would graduate. The logistic regression model was statistically significant, $\chi^2(3) = 78.496$, $p < .001$. The model explained 1.2% (Nagelkerke R^2) of the variance in graduation status and correctly classified 74.7% of the cases. Perhaps the low percentage (1.2%) can be explained by the fact that there are more factors that contribute to graduation than gender, race, and developmental status. Gender, race, and developmental status had significant partial effects. Females were 1.362 times more likely to graduate than males. White students were 0.818 times more likely to graduate than non-White students. Non-developmental students were 0.814 times more likely to graduate than developmental students. The logistic regression equation was $\ln(ODDS) = -1.021 + .309(GENDER) - .200(RACE) - .206(DEV\_STATUS)$. Table 85 shows the classification table and Table 86 shows the logistic regression coefficient, Wald test, significance, and odds ratio for each of the predictors.

Table 85

Classification Table of Logistic Regression of Graduation Status and Gender, Race, and Developmental Status

	Observed		Predicted		
			Graduated Yes=1; No=0		Percentage Correct
			0	1	
Step 0	Graduated	0	7,334	0	100.0
	Yes=1; No=0	1	2,480	0	0
	Overall Percentage				74.7

a. Constant is included in the model.
b. The cut value is .500

Table 86

Logistic Regression Predicting Graduation Status from Gender, Race, and Developmental Status

		B	Wald	Sig.	Exp(B)
Step 1[a]	Gender(1)	.309	38.908	.000	1.362
	Race(1)	-.200	13.171	.000	.818
	Dev Status(1)	-.206	13.391	.000	.814
	Constant	-1.021	252.442	.000	.360

a. Variable(s) entered on step 1: Gender, Race, Dev Status.

Summary of Results

This study sought to discover whether relationships existed for developmental status and student characteristics when compared to various measures of academic success. For students enrolled in MTH 100 from fall 2002 through summer 2013, variables such as gender, age, race, math subtest scores, pass/fail status in MTH 100, college grade point average, continuous enrollment, and college graduation were collected and tested. The statistical analyses of the data revealed some important results that can be utilized by the participating institution. The following items summarize the results pertaining to the research questions for this study.

Research question one and its sub-questions sought to determine the relationship between COMPASS math subtest scores and developmental mathematics status. A significant difference was found in all five of the questions. In each case, the students in the non-developmental group scored higher than the developmental students.

Analyses for research question two and its sub-questions looked at the relationship between ACT math subtest scores and developmental mathematics status. A significant difference was found in the entire population, males, and White students. In each case, the non-developmental students scored higher than the developmental students.

The analyses for question three and its sub-questions looked at whether there was a relationship between age and developmental status. A significant difference was found in all five of the questions and revealed that, on average, the developmental students were older than the non-developmental students.

The analyses for question four and its related sub-questions looked at the relationship between developmental mathematics status and the pass/fail status in MTH 100. There was a significant difference between non-White developmental students and non-White non-developmental students regarding pass/fail status in MTH 100. Non-White students that took developmental mathematics failed less often than non-White students that did not take developmental mathematics.

Analyses related to question five and its sub-questions looked at continuous enrollment and developmental mathematics status. A significant difference was found for the entire group, for females, and for White students, each of which showed that those in the developmental group attended more semesters than those in the non-developmental group.

The analyses for question six and its sub-questions were used to determine the relationship between college grade point average and developmental status. A significant difference was found every instance (entire population, males, females, Whites, and non-Whites). In all five of the situations, the developmental students had a higher grade point average than the non-developmental students.

Analyses related to question seven and its sub-questions looked at the relationship between graduation status of the developmental and non-developmental students. A significant difference was found for the entire population as well as when aggregating the data by females, Whites, and non-Whites. In each of these instances, of those that did not graduate, more did not take developmental mathematics.

The last set of research questions attempted to determine interaction effects among the variables in the study. Research question eight employed a logistic regression to determine the probability that a student would pass/fail MTH 100, using gender, race, and developmental status as predictor variables. The logistic regression model showed a significant interaction, and predictor variables of gender and race had significant partial effects.

Research question nine looked at the interaction effects between continuous enrollment and gender, race, and developmental status. A two-way ANOVA showed no significant interaction for either independent variable. Looking at the main effects separately, the only predictor variable to show significance was developmental status.

The tenth research question attempted to determine the existence of interaction effects between grade point average and gender, race, and developmental status. A two-way ANOVA resulted in non-significance in each case. But each main effect (gender, race, and developmental status) was statistically significant.

Finally, research question eleven looked at interaction effects between graduation status and gender, race, and developmental status. The logistic regression model was significant, and each of the predictor variables (gender, race, and developmental status) had significant partial effects. A summary of the results of the first seven research questions is shown in Table 87. Table 88 displays a summary of the interaction results.

This chapter provided an overview of the methods utilized in this study as well as a summary of the population. Next, the results from the analyses on each research question and the sub-questions were reported, followed by a summary of these results. The final chapter will provide an overview, discuss the results, outline implications for theory and practice, provide suggestions for future research, and finish with a conclusion.

Table 87

Summary of Non-Interaction Results

	Developmental Status	Male and Developmental Status	Female and Developmental Status	White and Developmental Status	Non-White and Developmental Status
COMPASS Math Scores	Significant	Significant	Significant	Significant	Significant
ACT Math Scores	Significant	Significant	Not Significant	Significant	Not Significant
Age	Significant	Significant	Significant	Significant	Significant
MTH 100 Pass/Fail Status	Not Significant	Not Significant	Not Significant	Not Significant	Significant
Continuous Enrollment	Significant	Not Significant	Significant	Significant	Not Significant
Grade Point Average	Significant	Significant	Significant	Significant	Significant
Graduation Status	Significant	Not Significant	Significant	Significant	Significant

Table 88

Summary of Interaction Results

	Interaction for Gender	Interaction for Race	Gender	Race	Developmental Status
MTH 100 Pass/Fail Status	Significant	Significant	Significant	Significant	Not Significant
Continuous Enrollment	Not Significant	Not Significant	Not Significant	Not Significant	Significant
Grade Point Average	Not Significant	Not Significant	Significant	Significant	Significant
Graduation Status	Significant	Significant	Significant	Significant	Significant

CHAPTER V:

CONCLUSIONS AND IMPLICATIONS

This chapter brings together the purpose and design of the study, which was to discover whether certain measures of academic success were related to developmental status and student characteristics at a public two-year institution in Alabama and subsequently attempt to determine the effectiveness of the institution's developmental math classes. What follows is an overview of the study, a discussion of the results, implications for theory and practice, and finishes with suggestions for further research followed by a conclusion.

Overview of the Study

The purpose of the study was to conduct an analysis looking at developmental status along with student characteristics and their relationship with particular measures of academic success. Discovering the existence of such relationships potentially reveals the level of effectiveness of the developmental mathematics program at the participating institution. Additionally, as outlined in the conceptual framework used in this research (Terenzini & Reason, 2005), faculty and administrators are able to create organizational contexts, classroom experiences, and peer environments that will help students succeed based on the results of this study. By understanding the trends related to academic success, administrators and practitioners at this institution are granted a firm foundation on which to build policies, strategies, activities, and experiences (Terenzini and Reason's organizational context) to enhance student learning. According to said scholars, students bring to college a set of background experiences; it is important for the institution to create an environment that will provide those enrolled with the greatest chance of achieving academic success. By using their model as a lens for which to view the results of this research, the information gleaned here attempts to contribute to students' academic success at the participating institution for years to come.

It is important to note at this point in the discussion the implication of "significance" as found in this study. Keep in mind that the goal of developmental courses is for students that lack necessary skills to overcome that disadvantage. In particular, those not ready for a college-level math class would hope to do as well as the students that did not need remediation ("as well as" essentially means that there would be no significant difference between the two groups). Therefore, no significant difference in the comparisons is in fact an encouraging result – it implies that the remediated students performed as well as the exempt students.

Thus an aim of this investigation was to look at whether the remediated students performed on par with the exempted students in the first college-level math course along with the other measures of academic success listed below. This study adds to the literature on effective evaluation of developmental classes, in addition to the relationship between age, gender, and ethnicity in terms of college graduation status, college grade point average, continuous enrollment in college, and ACT/COMPASS math subtest scores.

By using the remediated-exempted research design, this study looked at a number of variables related to the students at the institution that enrolled in the first college-level course and analyzed the results. By understanding the history of developmental education, the number of colleges that offer these classes, the multitude of students that need this training, and the most effective way to evaluate program goals, administrators, researchers, and practitioners can work together to give students a better chance of success.

Discussion of the Results

This section discusses the results for each of the eleven research questions and the corresponding sub-questions. The research questions analyzed the developmental and non-developmental groups as a whole, and each research question had three to four sub-questions that were analyzed according to the various outcome variables. Interaction effects were also explored for each of the academic outcome variables (pass/fail status in MTH 100, continuous enrollment, grade point average, and graduation status).

Overall, the results of this study point out important considerations for the participating institution according to the conceptual framework utilized in this study. Pascarella and Terenzini's (2005) college impact model implies that there are multiple sources of influence that enhance institutional effectiveness, which, in turn, enhance student experiences. Of course, students bring background characteristics with them to an institution and spend much of their first year in the process of unlearning attitudes, beliefs, and values and learning new ones. But the organizational context and the peer environment (which they refer to as the college experience) work together and impact academic outcomes.

Within the organizational context, Pascarella and Terenzini (2005) have claimed that structures, curricular configurations, faculty recruiting and reward policies, and budgetary and staffing issues all have the potential to play a role in shaping the experiences of students, whether directly or indirectly. So the participating institution can benefit by being mindful of these facets. But it is more than just buildings and organizational charts. Pascarella and Terenzini believe it has more to do with what the institution *does* as opposed to what the institution *is*. They argue that one major concern is that there is no person or group that is in charge of the first year experience at the participating institution. Policies should be in place that allow the institution to implement and coordinate a comprehensive approach to the first year of college. This individual or group (made up of both faculty and staff members) would meet planning, coordinating, and delivery needs of both academic and extra-curricular activities with a specific focus on the student's first year.

Considering the peer environment, decision-makers at the institution can improve student success by accounting for the curricular, classroom, and out-of-class experiences that contribute to student learning. Not only the actual courses taken, but also the pedagogy students are exposed to as well as the living quarters, work hours, extra-curricular activities, hours spent studying, and family support operate together to influence student learning and persistence. By understanding this aspect of the model, the participating institution can be mindful of how faculty decisions (somewhat regulated by the institution) and external factors (outside of institutional control) play a role in student learning, persistence, and success.

Taking the above into consideration, the results discussed below constitute a few layers out of many that paint the whole picture of effectiveness. But, at a minimum, administrators can be mindful of how important, according to Pascarella and Terenzini (2005), the background characteristics, the organizational context, and the peer environment are to a student's chances for success. Therefore, along with all of the recommendations provided later on, policies and practices must be in place to facilitate student success according the conceptual framework used here.

Part One: COMPASS Math Subtest Scores

Hypothesis one and its sub-questions sought to determine whether there was a significant difference between COMPASS math subtest scores of developmental math students and non-developmental math students. A significant difference was found in each instance. For every analysis in this category, the non-developmental students scored higher on the COMPASS math subtest than the developmental students. This is expected since lower scores coming into college (as shown by the math subtest scores) is what places a student in developmental courses. However, lower scores might provide some indication of the effectiveness to the developmental classes. If the developmental students were significantly lower in math skills before taking developmental math, then continued on to achieve academic success (as found in previous analyses), the developmental math classes were effective in helping students overcome those knowledge gaps shown from the COMPASS entrance exam.

Part Two: ACT Math Subtest Scores

Hypothesis two and the corresponding sub-questions sought to discover if there was a difference between ACT math subtest scores of developmental math students and non-developmental math students. A significant difference was found for the two groups as a whole, for males, and for White students. In each of these three cases, the non-developmental group of students scored higher on the ACT math subtest than the developmental students. As stated in Hypothesis 2, this can be seen as evidence that the developmental math classes were effective since the developmental students overcame a knowledge gap (evidenced in the subtest scores) in order to succeed. Thus the developmental students in the study entered college lacking the skills necessary to begin college-level work and it appears that developmental mathematics contributed to their eventual academic success.

It is important to note the results for females and non-Whites, even though the differences were not significant. The female and non-White developmental students, on average, reported lower mean scores on the ACT math subtest when compared with their respective non-developmental groups in this study. Yet the differences were not strong enough to be significant.

Thus, overall, the non-developmental female and non-developmental non-White students had some of the necessary skills needed to enter the first college-level math course, but they still reported scores similar to those that needed remediation. For the female students, this might be explained by the existing literature positing that this gender has a disadvantage in STEM fields (Gunderson, Ramirez, Levine, & Beilock, 2012; Maple & Stage, 1991). For the non-White students, this result might validate some of the research in existence that claims non-White students are at a disadvantage when it comes to performance on standardized tests (Kao & Rutherford, 2007; Sackett, Hardison, & Cullen, 2004).

Part Three: Age

Hypothesis three and its sub-questions looked at whether there was a significant difference in age of developmental and non-developmental students. A significant difference was found in each instance. For all five analyses in this category, the developmental groups, on average, were older than the non-developmental groups. This might be attributed to the fact that many students in the developmental group, for one reason or another, took time off before attending or returning to college. Additionally, the continuous enrollment results affirm these age outcomes. If enrolling in developmental classes extends the time to degree, then developmental students would be older than non-developmental students at the time of enrollment in MTH 100, even for those that did not take time off before entering college.

Part Four: Pass/Fail Status in MTH 100

Hypothesis four and its sub-questions attempted to determine a relationship between developmental mathematics status and the pass/fail status in MTH 100. A significant difference was found when analyzing the non-White developmental students and the non-White non-developmental students. In fact, non-White students that took developmental mathematics failed less often than non-White students that did not take developmental mathematics. The non-White developmental students seemed to be better prepared for the first college-level math course when compared to the non-White non-developmental students. This occurrence might be explained by the research stating that minority groups, namely Blacks and Hispanics, are at a disadvantage when it comes to math achievement (Bahr, 2010a). In other words, those non-developmental minority students whom (by placement testing standards) were ready for the college-level course, were actually at a disadvantage in that course. The non-developmental minority students perhaps had a lower degree of understanding of some of the math concepts as well as soft skills needed to complete the course (e.g., successful study habits, time management, self-efficacy (Rawley, 2007), note-taking skills, and positive self-talk).

Part Five: Continuous Enrollment

Hypothesis five and the corresponding sub-questions looked at determining whether there was a significant difference between continuous enrollment of developmental math students and non-developmental math students. A significant difference was found for the questions analyzing developmental status alone, female, and White students. In every significant case, the developmental group attended more semesters than the non-developmental group. This is understandable since placement in developmental courses adds course requirements and extends the time to degree. However, developmental students attending more semesters can be seen as a positive outcome. If a developmental student has the same number of semesters attended or less than the non-developmental student, it might imply that the developmental student either completed earlier or did not continue at all. Considering the latter, females, Whites, and the developmental group as a whole appear to have been retained at a higher rate than the corresponding non-developmental students.

The results from the continuous enrollment questions concerning males and non-White students are also worthy of note. Even though the relationship was not strong enough to be considered significant, the mean number of semesters attended by developmental students in each category (both for males and for non-Whites) was greater than the mean number of semesters attended by non-developmental students. Thus it still appears that taking developmental mathematics helped these two groups of students persist. The non-significance here might be contributed to gender and racial stereotypes. In many cases, males are expected to be more proficient at math when compared to females (Maloney, Waechter, Risko, & Fugelsang, 2012). With that assumption, a male that places in developmental mathematics might develop feelings of inadequacy that negatively affect his ability to continue and persist. For non-White students, existing research highlights how this group is underrepresented in higher education (Ward, Strambler, & Linke, 2013). Thus when non-White students are placed in developmental mathematics, it possibly turns into a self-fulfilling prophecy in which the disadvantaged student does not expect to succeed and hence does not persist.

Part Six: College Grade Point Average

Hypothesis six and its sub-questions sought to find whether there was a significant difference between college grade point average of developmental math students and non-developmental math students. A significant difference was found among every group (developmental status alone and developmental status with male, female, White, and non-White). In the analysis for each question in this category, the developmental students had a higher grade point average than the non-developmental students and appeared to have performed better than the non-developmental students. Therefore, taking developmental math appeared to help students earn a higher grade point average in this study. Perhaps the developmental mathematics class(es) benefited students in more ways than overcoming math skill deficiencies. Soft skills such as successful study habits, time management tips, efficient note-taking skills, and organizational skills would prove useful in classes beyond the developmental realm. Hence students taking the remediated route were instilled with important skills that taught them how to be a college student and subsequently contributed to higher grades earned in later courses.

Part Seven: Graduation Status

Hypothesis seven and the corresponding sub-questions attempted to determine the relationship between graduation status of developmental math students and non-developmental math students. Developmental mathematics seemed to help students graduate since there were more graduates in this group than expected and less graduates in the non-developmental group than expected. In other words, of those that did not graduate, more did not take developmental mathematics. Therefore it appears that taking developmental mathematics at the participating institution positively contributed to graduation. This significance was also found for female developmental students, White developmental students, and non-White developmental students. This might imply that taking developmental mathematics helped students graduate. And even when no significant difference was found (male developmental students compared to male non-developmental students), this would imply that the remediated group did as well as the exempt group, which still plays in the developmental student's favor. This occurrence might be due to the fact that, after being able to meet the rigorous demands of developmental mathematics, students grew in maturity and determination and were subsequently able to carry those attributes into other classes and eventually complete their program of study.

Part Eight: Interaction Effects on Pass/Fail Status in MTH 100

Hypothesis eight attempted to determine the probability that a student would pass MTH 100 depending on gender, race, and/or developmental status. The logistic regression model did conclude with a significant relationship for the interaction, albeit weak. Therefore it seems to be the case that passing the first college-level math course depended more on factors other than gender, age, and developmental status. This study did not explore influences such as motivation, family support, family/job obligations, etc. But it seems plausible that, based on the low probability associated with the predictor variables in this model, other factors play a larger role in a student passing MTH 100. Gender and race had significant partial effects, implying that these demographic variables do have an impact on a student's chances of success in the first college-level course. This is important to administrators to be aware of, especially for those students that are at a disadvantage that, as it appears from this model, are beyond their control. By being intentional about services offered to at-risk students, institutions can create an organization and peer environment (Pascarella & Terenzini, 2005) for students that gives them a better chance at academic success.

Part Nine: Interaction Effects on Continuous Enrollment

Interaction effects between continuous enrollment and gender, race, and developmental status were explored in hypothesis nine. The two-way ANOVA concluded that there was no significant interaction for gender, race, and developmental status on continuous enrollment. So number of terms enrolled could not be predicted by these variables. The only significant main effect was with developmental status. So being male/female or White/non-White does not seem to predict how many terms a student will enroll. But taking developmental mathematics did seem to do so. Since some students get discouraged when the time to degree is extended, the participating institution could consider offering fast-track options. For instance, faculty could provide training for students prior to taking the entrance exam in order for students to brush up on skills and possibly bypass developmental classes. When students do test into these training courses, they could be offered in such a way that students complete them at a faster pace.

Part Ten: Interaction Effects on Grade Point Average

Hypothesis ten attempted to determine whether gender, race, and/or developmental status predicted a student's grade point average. The two-way ANOVA concluded that there was no significant interaction between gender, race, and developmental status when considering a student's grade point average. But all three predictor variables had significant main effects. In other words, a student being male or female, White or non-White, and remediated or exempt were shown here to be related to a student's earned grade point average. The participating institution can utilize these results and carefully create a peer environment (Pascarella & Terenzini, 2005) that best improves student learning. By focusing on the curriculum, the classroom experiences, and the fact that faculty decisions have an impact on academic outcomes (Pascarella & Terenzini), administrators can provide support and guidance that will train students to be successful.

Part Eleven: Interaction Effects on Graduation Status

Hypothesis eleven looked at determining the probability that at student would graduate depending on the student's gender, race, and/or developmental status. The logistic regression model was significant, as were the partial effects for each predictor variable. Again, as was the case with hypothesis eight, the model was a weak predictor. Therefore it seems that there are other influences that carry more weight for predicting whether or not a student will graduate rather than gender, race, and developmental status. Nonetheless, the significance shows there is at least some chance that gender, race, and developmental status predict graduation. So institutional decision-makers can be mindful of the disadvantageous demographic characteristics and implement policies and practices to help these students succeed.

Essentially, the results of this study seem to imply that, during the eleven-year study period, the developmental mathematics courses at the participating institution were effective. In every category (referring to developmental status, male, female, White, and non-White), the remediated group performed on par with the exempt group for pass/fail status in MTH 100, graduation status, and grade point average. The only instances in which results were not in favor of the developmental group were the analyses concerning continuous enrollment, COMPASS/ACT math subtest scores, and age. Yet these results were expected due to the nature of the questions.

The literature discussed earlier pointed out that developmental classes have been around since the inception of American higher education (Breneman & Haarlow, 1998; Ignash, 1997; Keimig, 1983; Merisotis & Phipps, 2000), but many policymakers and administrators to date are pressuring institutions to remove the courses from the college realm (Adelman, 1996; Bahr, 2008b, 2010; Blanchette, 1997; Hebel, 1999; McCabe & Day, 1998; Phipps, 1999). Since researchers lament that there are no efficient evaluation procedures to determine the effectiveness of these programs (Bailey, 2009; Bettinger & Long, 2005; Boylan, Bonham, & Bliss, 1997; Calcagno & Long, 2009; Grubb, 2001), then many people do not see their worth. This research provides the participating institution with data useful for making important decisions regarding whether or not to continue offering developmental mathematics. Students in this study not ready for college-level work might have missed out on a chance of earning a higher degree had it not been for developmental mathematics. The study at hand also presented an evaluation method that the participating institution can continue to utilize in order to determine the ongoing effectiveness of the developmental classes (potentially for mathematics, English, and reading). By using the remediated-exempted research design, each analysis clearly outlined the usefulness of developmental mathematics at the participating institution during the study period.

Another problem noted in the literature review addressed the vast number of students needing, and subsequent colleges offering, developmental mathematics. Due to excessive numbers in both of these areas, diminishing the reliance on these training courses should be an aim of any group vested in the education of our country's citizenry. Through this study, the results obtained are helpful in this area. Higher education institutions can team up with area high schools and build a bridge, so to speak, from high school to college. This partnership could provide basic information regarding how college works (admission process, applying for scholarships, developing schedules, importance of joining organizations, etc.). Additionally, pre-college teachers could be trained concerning subject-specific college-level skills necessary for students to learn, as well as behavior-specific qualities (e.g., responsibility, punctuality, and participation) that contribute to academic success. Finally, the partnership could work toward providing the exiting seniors with a crash course in necessary subject-specific skills before taking the college placement exam. By doing this, students can hopefully brush up on necessary skills and begin at the right point for their level of knowledge, which in turn reduces the number of students needing pre-college training upon entering postsecondary education. The results of this study identified characteristics of students in the institution's service area that could be intentionally provided with these interventions.

The results from this study also showed that students definitely bring to college a range of background characteristics, which are important for institutions to understand. As noted in Terenzini and Reason's (2005) college impact model, the framework used in this study, colleges can utilize knowledge of student pre-college characteristics to create a meaningful environment (termed the organizational context) in which the student can flourish. By placing time and energy into understanding the students being served, these environments created are extremely important since they play a role in positive student outcomes, as noted in the model. Therefore, from this analysis, gender, race, age, and background knowledge were all substantial background characteristics important to academic outcomes, and administrators and practitioners can invest time and energy into creating environments and an organizational context that will, in turn, contribute to meeting the needs of students and helping them succeed.

Implications for Theory and Practice

Discussions continue regarding the availability of developmental education at the college level. Billions of dollars are spent annually on these programs in this country (Denley, 2013; Saxon & Boylan, 2001). Many institutions are either removing the courses completely (Kolajo, 2010; Lively, 1993) or investing substantial amounts of money toward resources for redesigning the classes (Cullinane & Treisman, 2010; Le, Rogers, & Santos, 2011; Merseth, 2011). Therefore the results of this study are important to the participating institution concerning decisions related to its developmental offerings.

First, administrators and practitioners can benefit from results of the analyses regarding ACT/COMPASS math subtest scores. In those that were significant, the developmental groups had lower scores than their respective non-developmental groups. Understandably, students needing developmental training have skill deficiencies and are more than likely in those classes due to low performance (although there are instances of students starting at the lower levels by choice). The researcher's goal was to show whether the institution's developmental math classes were effective during the study period. The developmental students, more often than not, began the classes with a gap in knowledge that was overcome, as is evident by the research results in questions discussed prior. An interesting point is that the female and the non-White sub-questions for the ACT math subtest scores were both insignificant. In other words, comparatively speaking, the non-developmental females and the non-developmental non-Whites performed at the same level on the ACT math subtest as their developmental counterparts. The weak relationships might lend themselves to prior research stating that females and non-Whites are at a disadvantage on standardized tests (Bahr, 2010a; Bailey, Jeong, & Cho, 2010; Goldstein, Burke, Getz, & Kennedy, 2011; Gunderson, Ramirez, Levine, & Beilock, 2012; Rawley, 2007; Walker & Plata, 2000). This is an important consideration for administrators regarding placement testing and cut scores for entrance into college courses. By understanding these trends, institutional decision-makers can provide a crash course in standardized test-taking skills as well as subject-specific skills (available to all students, but females and non-Whites in particular), which could help the students earn higher scores.

Second, the results concerning age are very important to administrators, practitioners, and educators. Many studies are available that point to andragogy (educating the adult learner) and its importance at the college level. This could be even more important for the developmental classes at the participating institution as shown by the results of this study (every result reported that the developmental groups were older than the non-developmental groups). By understanding the trending age range of students in the developmental classes, institutions could provide or give support for faculty training on methods and classroom practices that cater to adult learners in order to better reach the population of students in the classes. For instance, andragogy suggests that adult students be provided with opportunities to learn by connecting material to life situations, connecting life experiences to classroom experiences, showing the relevance of objectives, and giving them autonomy since they are more self-directed learners (Goddu, 2012).

Third, the fact that there were no significant differences found in the analyses for developmental status and MTH 100 pass/fail status for the entire population, for males, for females, and for Whites has significant implications. Many studies have been conducted where researchers found that developmental programs are not proven to work (Adelman, 2004a; Bahr, 2007, 2010a, 2012, 2013; Crisp & Nora, 2010; Cullinane & Treisman, 2010; Deil-Amen & Rosenbaum, 2002; Glenn & Wagner, 2006), regardless of demographic data such as gender and race. However, the results from this portion of the study showed the developmental groups performing as well as the non-developmental groups for the selections listed above. Therefore it seems that developmental mathematics did contribute to academic success in regards to passing the first college-level mathematics course at the participating institution. This result provides administrators and other decision-makers at the participating institution with needed information concerning the vitality of developmental math classes. Since the groups listed here performed as well as the non-developmental students, developmental mathematics classes were effective.

Moreover, the sub-question regarding pass/fail status in MTH 100 for non-White students revealed another important implication. A significant difference in this analysis showed that the groups did not perform equally. In fact, the non-White developmental students failed MTH 100 less often than the non-White students that did not need remedial math. Thus it appears that developmental mathematics actually helped non-White students pass the first college-level math course. Perhaps the training courses were successful in giving students the skills they needed and lacked upon entering college, and administrators could take another look at keeping these programs in order to help students reach their academic goals. Administrators and practitioners at the institution should be informed of the existing research regarding minority groups being at a disadvantage in math achievement (Bahr, 2010a) and the fact that the results of this study affirm that research (i.e., the non-White non-developmental students failed more often than the other group). Doing so allows these decision-makers to develop specific aims at reaching minority students in an effort to help them pass this college-level course.

Fourth, college leaders can reach out to the male and non-White groups due to the results of this study regarding continuous enrollment. Naturally, enrolling in developmental courses could extend the time to completion since more courses are required before one can actually begin program requirements. Developmental students recording fewer semesters than non-developmental students could be a sign that those needing the training courses either completed earlier or were not retained. Considering the latter, the findings in this study might imply that the developmental students did not drop out due to the fact that the mean semesters attended was higher for each question in this set (although the relationships for both males and non-Whites were not strong enough to be significant). Many studies found that the time to degree is not worth it for developmental students and that it contributes to attrition (ACHE, 2011; Kolajo, 2010). But, considering the results of this study as a whole, it seems that the developmental mathematics program at the participating institution is successful and the additional terms needed to complete did not deter the developmental students in this study. For the males and non-Whites (to which there was a possibility that they dropped out), administrators have a few choices worthy of consideration. Since males suffer from the stereotype to be proficient in science, technology, engineering, and mathematics (STEM) fields (Maloney, Waechter, Risko, & Fugelsang, 2012), this gender might feel inadequate by testing into pre-college courses. Perhaps communicating opportunities like the Science, Math, and Engineering (SME) Club, peer groups, STEM jobs, and salaries of high school graduates compared to college degree-holders would provide added incentive to persist. And since non-Whites are underrepresented in higher education (Ward, Strambler, & Linke, 2013), some in this group might already feel they don't belong, and testing into pre-college classes might affirm that belief. Therefore administrators and practitioners can provide experiences with positive reinforcement, encouragement, highlights of non-Whites in STEM fields, and highlights of non-Whites holding degrees to encourage them to persist.

Fifth, administrators can make note of the important results that appeared in the analyses to determine the relationship between developmental status and college grade point average. In every case, the developmental groups had higher grade point averages than the non-developmental students. Therefore it appears that taking developmental mathematics helped students at the participating institution earn a higher GPA. This might be attributed to the fact that the rigor of the developmental math classes prepared students for the workload to expect in subsequent courses in their programs, and therefore passing the developmental math classes paved the way for doing well in future courses. Some scholars claim developmental mathematics is a graveyard (Merseth, 2011) and that the students needing these classes are sub-par academics (Brubacher & Rudy, 2008; Keimig, 1983). But the findings here suggest otherwise. Even though some see the classes as inappropriate at the college level (MacDonald, 1997, 1998, 1999; McCabe & Day, 1998; Moss & Yeaton, 2006) and belittling (Bahr, 2008a), it is seems that students needing the training might be dedicated to achieving academic success.

Thus administrators can utilize the results here in making claims in favor of keeping developmental mathematics at the participating institution.

Additionally, assuming that the developmental classes did instill student success qualities and were contributing factors to earning a higher grade point average, college decision-makers can revamp required orientation courses with the goal of exposing every student (regardless of developmental status) to training on the soft skills necessary for becoming a successful college student. Since the non-developmental students recorded lower grade point averages in the study, it is important to provide guidance to them as well. This guidance can be subject-specific skills as well as training for learning how to be a college student.

Finally, there were interesting results for college decision-makers concerning the relationship between developmental status and graduation status. The numbers reported are substantially low (consider the mission of the institution and the fact that many enroll with no plans of graduating or earning a certificate). But the purpose was to compare the outcomes of the two groups. Again, based on the remediated-exempted design suggested by other scholars (Bettinger & Long, 2005, 2009; Boggs, 1997; Dumont, 1982; Sawma, 2000; Smith, 1983), if the remediated group performs as well as the exempted group, developmental programs are considered effective. In every case except for males, there was a significant difference. Moreover, in every case except for males, of those that graduated, more students took developmental mathematics. So it seems that developmental mathematics actually helped students complete a program, and the non-significance of the male sub-question might not be considered a sign of ineffectiveness. There were more male non-developmental students than expected in the group that did not graduate. It might be the case that going through the developmental mathematics classes gave students more than just the math skills needed to succeed, but also the motivation and vision necessary to achieve academic success in terms of graduating or earning a certificate. Practitioners can incorporate seminars and/or workshops (available for all students in MTH 100, but place an extra focus on males) with aims at educating them on the benefits of earning a college degree. For instance, conducting a seminar that outlines salaries based on degree held reminds students of the "big picture" and can provide the needed motivation some students need. For many students at the community college, they do not have a cheerleader in their support group as many are first-generation college students. Sometimes it is easier to just quit. College leaders can be proactive and provide the encouragement that some students rely on to keep working and complete a program.

As noted in the preceding paragraphs, there are many important implications that came about from this study. Considering the findings as a whole, it would seem that all of the student characteristics played an important role in academic success at the participating institution during the study period. Moreover, it could be concluded that, after analyzing the results for each of the seven questions and the related sub-questions, the developmental mathematics program at the participating institution was effective during the study period from fall 2002 through summer 2013. According to the college impact model by Terenzini and Reason (2005), these are background characteristics that, as demonstrated in this study, contribute to positive outcomes for academic success.

Suggestions for Further Research

After conducting the research presented in this study, additional approaches on this topic are warranted. The following items constitute a list of such suggestions. First, research suggests that many institutions are not evaluating the developmental programs in an adequate manner (Bahr, 2008b; Boylan & Saxon, 2010; Boylan, Bliss, & Bonham, 1997; Breneman & Haarlow, 1998; Calcagno & Long, 2009; Collins, 2010; Grubb, 2001). By using this remediated-exempted design, institutions looking for a systematic analysis could divide students that take the first college-level course into two mutually exclusive groups (developmental status and non-developmental status). Future analysis should consider procedures as outlined in this study. If significant differences are found in favor of the developmental students, then the developmental programs could be considered effective. If significant differences are found in favor of the non-developmental students, then the developmental programs could be considered ineffective. If no significant differences are found, then the developmental programs could be considered effective since the underprepared group performed as well as those that did not need the training.

Second, using a design similar to that described in this study, the developmental reading and developmental English classes could evaluate the effectiveness of their courses. Institutions could divide students that enrolled in the first college-level English course (ENG 101) into two mutually exclusive groups (developmental and non-developmental). Looking at each group along with gender and race, researchers could run analyses concerning pass/fail status in ENG 101, graduation status, college grade point average, continuous enrollment, ACT/COMPASS English subtest scores, and age. The effectiveness of the training course(s) is evident if the developmental students performed as well as the non-developmental students.

Third, since many programs at two-year institutions accept MTH 116 (Basic Mathematics with Applications) as the math class needed to meet program requirements, a similar study could be designed that analyzes performance in stated course along with MTH 100 since some students need a developmental class in order to take MTH 116. In other words, gather enrollment data for all students that enrolled in MTH 100 and/or MTH 116 during a specified time period. Then divide the population into two groups – developmental and non-developmental students. Run the statistical analyses as described in this study in order to gain a more thorough picture of the effectiveness of developmental classes since not every student takes MTH 100.

Fourth, future studies could complete similar research but with a redesign of certain variables. Since attending more semesters does not imply success, another study could redefine persistence as something other than "number of terms completed." Also, since community college students do not always enroll in order to graduate (earn credentials for promotion, enhance job skills, transfer and two-year degree is irrelevant concerning chosen field, etc.), using a different definition of graduation/completion could be useful.

Fifth, using a design similar to the one implemented in this study, future research could make a distinction between the developmental level required. This study labeled students as having developmental status regardless of how many training courses were needed. Current research does claim that it makes a difference in terms of success outcomes depending on how many classes are needed before a student can reach the college-level course (Adelman, 2004a; Bahr, 2007, 2012; Hoyt, 1999). Thus a study that distinguishes the developmental level would be warranted.

Sixth, using a design similar to the one utilized in this work, further research that looks at interaction effects and the subsequent outcomes would be interesting. Current literature shows differences among success when comparing males versus females and Whites versus non-Whites. So a study analyzing whether differences exist across gender and race would add to the literature in these areas.

Seventh, due to the participating institution changing database systems during the eleven-year study period (namely the 2010-2011 academic year), ethnicity data was not available for the entire population since that demographic data was not collected in the former enrollment requirements. A study utilizing the research design described here that also analyzes outcomes based on race and ethnicity would be beneficial.

Eighth, future researchers could use this research design but with a mixed methods approach to incorporate motivational factors such as work requirements, outside obligations, transportation, etc., since many students are faced with obstacles outside of an institution's control.

Ninth, this research methodology could be used at institutions beyond the realm of the public community college to see if the results are generalizable for more than the participating institution. Private two-year colleges, four-year institutions (both public and private), private for-profit organizations, and private not-for-profit institutions expectantly present interesting results.

Tenth, following the college impact model (Terenzini & Reason, 2005), a study could be designed that incorporates classroom experiences at the developmental level and their impact on academic success. A researcher could find a variety of course designs and institutional requirements (lab-based, mastery-level developmental courses; problem-based case studies incorporated in curriculum; hybrid developmental courses; online developmental courses; optional developmental courses; traditional developmental courses; complete redesign of developmental curriculum (Merseth, 2011); and basic skills crash course prior to starting college-level math class). After collecting enrollment data from students enrolled in the various settings described above, the researcher could run analyses to determine the most effective course design and/or institutional requirement. These results would benefit a wide range of audiences regarding the most effective way to offer developmental classes.

Conclusion

There has been an increase in pressure for programs in higher education to provide data regarding accountability, and developmental programs are not exempt. More and more students come to college underprepared – and likewise more and more institutions fail to adequately collect data on program effectiveness. Dwindling budgets wreak havoc on programs that are not communicating their worth.

This study proceeded in an attempt to discover whether developmental status along with student characteristics contributed to certain measures of academic success at a rural community college in Alabama, and subsequently reveal to the institution the level of effectiveness of its developmental mathematics program in order to prove its worth regarding student success. While the scope of the data used in this study is quite limited, the design seems to be rather useful. Since there is no agreed-upon means to evaluate the effectiveness of developmental programs to date, it is difficult for an institution to look at what its skills training courses are doing and decide whether those things are being done in a satisfactory manner. Because college performance paves the way for predicting socioeconomic outcomes (Kerckhoff, Raudenbush, & Glennie, 2001), administrators and practitioners cannot overemphasize the importance of this issue. These students make up our country's workforce and higher education institutions give them a hope for a future rather than let them slip through the cracks as just another person that fits into the mold. Knowing the characteristics that potentially contribute to student success can be valuable to an institution in terms of how it designs classroom experiences, how it creates peer experiences (Terenzini & Reason, 2005), how it sets up course cut scores, and so on. Although this study did not yield results that are generalizable to multitudes, the design and approach to the research could be useful to a number of institutions and therefore affect the lives of many looking for a better future.

All in all, this study provided evidence that developmental mathematics classes can help students reach academic goals. Moreover, the results have the potential to contribute to academic success at the participating institution. By understanding the results from this study, administrators have valuable data on background characteristics and demographic data that contribute to academic success, and these officials can be intentional on implementing policies and forming groups that meet these needs. Additionally, this study revealed an evaluation model for the institution (using enrollment data already collected) that can be replicated in the future for purposes of ensuring program effectiveness. The results formed by this analysis provided a glimpse into a developmental mathematics program at a small, rural two-year institution in Alabama that seems to be doing what it takes to help students succeed. There is a need for a much closer look at developmental education in this country – what is causing it, why it is so widespread, how to measure its effectiveness, and how to make it beneficial to those that need the training. The results here have shown that developmental status, gender, race, ACT/COMPASS math subtest scores, and age have an important role in academic success (namely college-level course completion, grade point average, persistence, and degree/program completion). Although this study did not provide an intensive design that is generalizable to all institutional types and programs, the various relationships explored were important and warrant further study.

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Appendix A

Data Collection Request

180 Mtn View Rd
Alexandria, AL 36250

October 11, 2013

Dr. Teresa C. Rhea
Department of Institutional Planning and Research
Joe Ford Center, Room 344
405 Korner Street
Gadsden, AL 35903
(256) 549 – 8230

Dear Dr. Rhea:

I hope this letter finds you well. I am writing to request permission to use data from Gadsden State Community College in the research for my dissertation.

I will use information from fall 2002 through spring 2012 in order to determine the effectiveness of the institution's developmental mathematics program. I plan to do this primarily by comparing the passing rate in MTH 100 of students that needed developmental mathematics during the time period specified to the passing rate in MTH 100 of students that did not need developmental mathematics during the same academic years. Analyses will also be run pertaining to the participant's ACT/COMPASS math subtest scores, graduation rate, persistence, gender, age, and race/ethnicity. All findings will be shared with the institution.

I appreciate your time and consideration in this matter.

Thank you,
Sara Wheeler

Appendix B

Data Collection Request Consent

GADSDEN STATE
COMMUNITY COLLEGE
President's Office
P. O. Box 227 · Gadsden, Alabama 35902-0227 · www.gadsdenstate.edu

Memorandum

TO: Sara Wheeler

FROM: Dr. William O. Blow
President

DATE: October 15, 2013

SUBJECT: Access to Student Records

Approval has been granted to allow access to Gadsden State Community College student records in order to determine the effectiveness of the institution's developmental mathematics program. Analyses will be conducted pertaining to the participant's academic progress in Math 100, ACT/COMPASS math subtest scores, graduation rate, persistence, gender, age and race/ethnicity. No particular students will be identified in this study and all personally identifiable information will be kept confidential.

Dr. William O. Blow, Acting President Phone 256.549.8221 Fax 256.549.8288 bblow@gadsdenstate.edu

Appendix C

IRB Consent

Office for Research

Institutional Review Board for the
Protection of Human Subjects

THE UNIVERSITY OF
ALABAMA
RESEARCH

January 27, 2014

Sara Wheeler
ELPTS
College of Education
Box 870302

Re: IRB # EX-14-CM-018, "Developmental mathematics status and other student characteristics that contribute to student success at a two-year college in Alabama"

Dear Ms. Wheeler:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your protocol has been given exempt approval according to 45 CFR part 46.101(b)(4) as outlined below:

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Your application will expire on January 26, 2015. If your research will continue beyond this date, complete the relevant portions of Continuing Review and Closure From. If you wish to modify the application, complete the Modification of an Approved Protocol Form. When the study closes, complete the appropriate portions of FORM: Continuing Review and Closure.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer
Office for Research Compliance
The University of Alabama

358 Rose Administration Building
Box 870127
Tuscaloosa, Alabama 35487-0127
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Appendix D

Definitions of Key Terms

Andragogy. Learning strategies for the adult learner.

College grade point average (GPA). College GPA was defined as the college grade point average. The participating institution was on the semester system and used a four-point grading system, with final letter grade assignments having the following quality point values: A = 4, B = 3, C = 2, D = 1, F = 0. Grade point average was computed by computing the number of quality points earned during the semester (grade points multiplied by the credit hours). The total quality points was then divided by the total number of credit hours attempted.

Continuous enrollment. Continuous enrollment was defined as the total number of semesters that a student enrolled at the participating institution at the time of data collection. No weight was given to the number of hours taken per semester.

Credit-level mathematics (or college-level mathematics). Credit-level mathematics and college-level mathematics were both defined as the mathematics course entitled MTH 100-Intermediate Algebra at the participating institution. This was the first credit-level mathematics course available to students at this community college.

Developmental. Developmental was defined as not meeting standards for a college course. Debates are ongoing concerning the titles "developmental" and "remedial," and various terms are used to describe those not ready for college-level work, such as underprepared, basic skills, remedial, developmental, or interchangeably as remedial/developmental. Some distinguish between developmental and remedial by labeling developmental as teaching not only content in the subject area, but success skills as well (Moss & Yeaton, 2006). The terms "developmental" and "remedial" were considered as synonyms in this study.

Developmental math students. Developmental math students were defined as students who scored below 36 on the algebra portion of the COMPASS exam (the participating institution's placement entrance exam) or scored below 20 on the math portion of the ACT-test. Developmental math students were considered underprepared in math. If they started in MTH 090 – Basic Mathematics, then they were required to score a C (75 – 79) or better in the course and were required to pass a departmental final exam to proceed to MTH 098 – Beginning Algebra. For those that tested in MTH 098, they were required to score a C (75 – 79) or better in the course and were required to pass a departmental final exam to proceed to MTH 100 – Intermediate Algebra.

ENG 101. ENG 101 (English Composition I) is the first college-level English course at the participating institution.

Failing. Students were coded as "failing" if a "D," "F," or "W" were earned in MTH 100, such that a D = 60 – 69 and an F = 59 and below.

Graduation. Graduation was achieved when a student met the requirements of the participating school system for a two-year Associate of Arts Degree, a two-year Associate of Science Degree, a two-year Associate of Applied Science Degree, a Certificate, or a Short-Term Certificate at the participating institution.

Graduation status. A student was coded as "graduated" if a degree or certificate was earned during the study period from fall 2002 to summer 2013.

MTH 100. MTH 100 (Intermediate College Algebra) is the first college-level mathematics course at the participating institution, which is an intermediate algebra course with the following objectives:

- Demonstrate the ability to perform operations with rational functions.
- Demonstrate competent skills in graphing linear functions.
- Demonstrate the ability to write a linear equation.
- Demonstrate competent skills in functions by exhibiting the ability to evaluate a function.
- Demonstrate the ability to solve a linear system of 2 equations with 2 unknowns.
- Demonstrate the ability to graph a linear inequality in 2 variables.
- Demonstrate the ability to perform basic operations with radicals.
- Demonstrate the ability to perform basic operations with complex numbers.
- Demonstrate the ability to solve a quadratic equation.
- Demonstrate the ability to graph a quadratic equation.

MTH 100 students. MTH 100 students were defined as students who took MTH 100 during the 10-year period beginning fall semester 2002 and ending summer semester 2012.

MTH 116. MTH 116 (Basic Mathematics with Applications) is considered a college-level course at the participating institution and is the accepted math course for some of the technical and two-year degree programs with the following objectives:

- Demonstrate the ability to solve problems involving ratios.
- Demonstrate the ability to solve problems involving proportions.
- Demonstrate the ability to solve problems involving percents.
- Demonstrate the ability to solve problems involving simple interest.
- Demonstrate the ability to convert units within the metric system of measurement.
- Demonstrate the ability to calculate the probability of simple events.
- Demonstrate the ability to perform basic operations on integers.
- Demonstrate the ability to solve a linear equation.

- Demonstrate the ability to solve problems involving linear equations.

Non-developmental math students. Non-developmental math students were defined as those students who scored in the range of 20 – 22 on the ACT math subtest or 36 or higher on the algebra portion of the COMPASS math subtest placement exam. These students were not considered underprepared in mathematics and were not required to enroll in pre-college math courses.

Passing. Passing was defined as a grade of "A," "B," or "C," where A = 90 – 100, B = 80 – 89, and C = 70 – 79 for college-level math courses.

Pass/fail status. A student was coded as "passing" MTH 100 if an "A," "B," or "C" was earned. Scores of "D," "F," and "W" were coded as "failing."

Remedial. Developmental was defined as not meeting standards for a college course. Debates are ongoing concerning the titles "developmental" and "remedial," and various terms are used to describe those not ready for college-level work, such as underprepared, basic skills, remedial, developmental, or interchangeably as remedial/developmental. Some distinguish between developmental and remedial by labeling developmental as teaching not only content in the subject area, but success skills as well (Moss & Yeaton, 2006). The terms "developmental" and "remedial" were considered as synonyms in this study.

SME Club. Science, Math, and Engineering Club (at participating institution)

STEM field. A course in a science, technology, engineering, or mathematics discipline.