

ABSTRACT

WILSON, YOLANDA SHEREE'. Impact of Math Study Skills Co-requisite Courses on Student Success in Pre-Calculus at an Urban Community College. (Under the direction of Michelle Bartlett).

Multiple levels of developmental coursework have hindered many students from completing their remedial requirements, and consequently, few ever enroll or complete the subsequent gatekeeper courses. The declining success rates of developmental students caused many researchers to examine not only the effectiveness of the remedial coursework, but the very placement tests that indicated their need for remediation in general. With so many developmental students failing to earn a college credential, researchers questioned the historical model of using placement tests to determine college readiness, and instead, posed alternative placement methods as a more reliable predictor of college readiness. The Multiple Measures Policy in the North Carolina Community College System, created to provide alternative methods of placement based on years of persistence and performance in high school courses, was implemented to mitigate the challenges of placement tests by allowing students with a high school GPA of 2.6-2.99 to enroll in a high risk gatekeeper mathematics course and math study skills course simultaneously. This study explored the effectiveness of such a co-requisite model as more and more states have considered (or adopted) this intervention in hopes of improving retention and completion in academic programs.

Using propensity score matching, the researcher examined the math course success rates and credential completion of two groups of students: those who placed into curriculum level math and co-enrolled in a co-requisite math study skills course (MAT 001) based on their 2.6 to 2.99 high school GPA and those who took the college level math without the academic support. The researcher also identified three predictor variables (i.e. enrolled in a non-transfer degree,

enrolled full-time, and age) that strongly indicated membership in the dependent variable – in this case, enrollment in the co-requisite math study skills course. After a comparison was made between outcomes for the control and treatment groups, the researcher was able to determine that the co-requisite math study skills course did not have an impact on any of the college outcome variables (grade point average, transferability, and completion) and was deemed statistically insignificant.

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Impact of Math Study Skills Co-requisite Courses on Student Success in Pre-Calculus at an
Urban Community College

by
Yolanda Sheree' Wilson

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APPROVED BY:

Michelle Bartlett
Committee Chair

James Bartlett

Reynaldo Garcia

Carrol Adams Warren

DEDICATION

My educational journey began with my parents: Joseph Henderson and Eleanor Jean Triplett Henderson. My Dad, Alabama born, was a strong proponent of a college education and worked very hard to ensure that I had the foundation to excel at a university. My Mom, a Floridian, taught me that getting an education was not optional, to never give up even when life became challenging, and to always remember the importance of faith and family. They both began this journey with me many moons ago; they were my wings. But my husband, Dale Everett Wilson Sr., and our sons, Bryan, Brandon and Braxton, were my wind. Their love, support, and prayers propelled me forward and helped me finish what I began many years ago. And for those reasons and so many more, I dedicate my dissertation to them.

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African-American author, Alex Haley, once stated: “Anytime you see a turtle up on top of a fenced post, you know he had some help.” I am, like the turtle, incredibly grateful for all of those who helped me make that climb.

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CHAPTER 1: INTRODUCTION

National data has indicated that many students who place into developmental coursework never make it through their remediation funnel, and even fewer complete gatekeeper courses (Bailey, 2009; Bailey, Jaggars & Jenkins, 2015; Bailey, Jeong, & Cho, 2010). With so many developmental students performing poorly not only in the remedial coursework but also the gatekeeper courses, many wonder if the placement tests accurately measure students' aptitude to be successful in college level work, and if not, what is a more reliable predictor of college readiness (Belfield & Crosta, 2012; Hughes & Scott-Clayton, 2011; Ngo & Kwon, 2015; Scott-Clayton, 2012).

Although the developmental education system is designed to support access to a post-secondary degree, regardless of prior academic preparation, the challenges of doing so have been many (McCabe, 2000). To determine the college readiness of incoming students, community colleges most often use placement tests, either ACCUPLACER or COMPASS, as a part of their admissions process and establish cut-off scores to determine which remedial courses are needed in English, reading, and mathematics (Bailey et al., 2015; Belfield & Crosta, 2012). Consequently, students deemed not college-ready based on their placement test scores frequently take developmental coursework in English and/or math before beginning their college level curriculum, accumulating no college credit and exhausting much of their financial aid. National statistics indicate that roughly 60% of recent high school graduates take at least one remedial course, most frequently in developmental mathematics, but never earn a college credential (National Center for Public Policy and Higher Education and Southern Regional Board [NCPPE], 2010).

Collins (2008) found that “many students who need remedial courses find ways to avoid them or of those who do enroll, few complete their remedial courses and go to college level courses that count toward a degree” (p. 16). Attewell, Lavin, Domina, and Levey (2006) would agree, finding that of the community college students who enroll in developmental coursework, only 28% earn a degree within eight years compared to 48% of those who were not required to take any developmental coursework at all. Hodara and Jaggars (2014) state that “community colleges have begun to grapple with the poor outcomes of developmental students by experimenting with a range of reforms, with one of the most popular being *acceleration* strategies” (p. 247). With research from the Community College Research Center and funding from national philanthropic organizations like the Gates and Lumina Foundations, some states, including North Carolina, have made accelerated learning models a focus of statewide reform, to include but not limited to, multiple measures (Bailey et al., 2015; Belfield & Crosta, 2012; Hern, 2012). For the sake of this study, multiple measures is defined as using other sources of data beyond the placement tests, particularly high school information, as a means of determining college readiness and placement (Belfield & Crosta, 2012; Ngo & Kwon, 2015).

Problem Statement

According to Jaggars et al. (2015), “to support the long-term success of underprepared students, many community colleges are experimenting with accelerated developmental education models, which allow students to complete remediation and enroll in college-level math and English within a shorter time frame” (p. 3). Based on a study of 57 community colleges that spanned 10 states, 59% of community college students were referred to developmental education in mathematics, with 24% referred to a single math course, 16% referred to two courses, and 19% referred to three (Bailey et al., 2010; Jaggars et al., 2015). To understand the underlying factors

that contribute to the lack of progression within developmental courses, researchers began to explore issues with assessment and placement, and the impact this early determination has on developmental students.

Collins (2008) stated that “assessment and placement policies have emerged as high-yield activities to improve services for academically underprepared students” (p. 16). As with any single assessment, placement exams have measurement error; hence, some students are placed into developmental courses when they are ready for college-level coursework, and others are placed into college-level courses and are underprepared (Belfield & Crosta, 2012; Scott-Clayton, 2012). Researchers from the Community College Research Center recommended a practice that would mitigate the errors resulting from placement exams, determining that high school GPA was a better predictor of college readiness (Belfield & Crosta, 2012). As a result, the North Carolina Community College System adopted a multiple measures placement policy in 2013 that considered many variables for college readiness, including high school GPA, placement tests and ACT or SAT scores. As a result, North Carolina high school students (with a minimum high school GPA of 2.6) were able to take curriculum level courses without remediation (See Appendix A).

However, initial student success data revealed that students with a 2.6-2.99 high school GPA were less likely to persist or earn a C or better in the high-risk gatekeeper mathematics courses. To address this unanticipated outcome, the North Carolina Community College System (NCCCS) undertook a 2013-2014 Curriculum Improvement Project (CIP) and created the one-credit Math Skills Support course: MAT-001 to accompany Statistics and Pre-Calculus courses. Community colleges who had implemented the multiple measures policy were encouraged by the state to create a version of this co-requisite course to support those students enrolled in the high-

risk mathematics courses (See Appendix B). In the NCCCS Common Course Library, this course is described as “a supplemental lab for students in their first gateway math course. Colleges may choose to require this co-requisite for students who bypassed placement testing under the Multiple Measures for Placement policy as identified by college-established criteria.”

In this MAT 001 co-requisite study skills course, students receive 1 credit hour and 2 lab/contact hours per course and the grading is Pass/Fail. With characteristics of a learning community, MAT 001 is organized to provide students with mini-lectures and cooperative group activities. Each lesson reviews the content in the high-risk mathematics course, encouraging students to work together on assignments that emphasize the week’s material. Outside of class, students meet together to support each other, study course materials and work on online homework. In this collaborative environment, the teacher reviews basic math skills and invites questions to ensure understanding.

In response to the number of students within the 2.6-2.99 high school GPA who were having difficulties in the curriculum math courses, select North Carolina community colleges (Central Piedmont, Stanly, Gaston, Davidson County CC, and Guilford Tech) linked supplemental math co-requisite courses to these curriculum math courses to provide additional academic support. Through the Multiple Measures Grant funded by Completion by Design, these colleges gathered data over a five-year period to determine if this intervention had the desired outcome, and if so, what implications the results had on placement for these students and the academic support required for their success.

Significance of the Study

McCormick and Lucas (2011) assert that the “lack of college readiness in math substantially affects college success, workforce career readiness, and the competitiveness of the

United States in a global economy” (p. 19). According to Hagedorn et al. (1999), math is considered one of the most difficult courses and one of the larger leaks in the degree and transfer pipeline. Although the attrition may be due to a lack of college readiness, Hern (2012) states that “the more semesters of remediation a student is required to take, the less likely that student is to ever complete a college-level math” (p. 60). Researchers agree that it is not always due to students’ inability to learn college material, but because they fail to enroll in the next course in their remedial course sequence. The findings from the Community College Research Center are clear: the longer the remediation sequence, the more discouraging the pathway for students.

Hagedorn et al. (1999) concur that many students find mathematics the most challenging course sequence and frequently report high levels of math anxiety and lower completion rates. In a multi-state study of 57 community colleges, the Community College Research Center found that among “students who are placed three or more levels below college math, fewer than 10% ever go on to complete a college-level math course. Put differently, community colleges block more than 90% of these students before they get through the first gate” (Hern, 2012, p. 60). Based on these alarming statistics, Ali and Jenkins (2002) conclude that a strong correlation exists between success in college-level mathematics and the likelihood of completing a college degree.

To address this issue, Cox (2015) recommends that “efforts to improve developmental math outcomes across community colleges must focus on what actually happens inside classrooms” and not just assessment and placement (p. 283). Supporting the need for an accelerated co-requisite model, Hern (2012) espouses the benefits of immediately enrolling students in a gateway course while offering academic support at the same time. Not only does this model connect students to their curriculum coursework immediately, it also significantly reduces the developmental sequence and the likelihood of dropping out of college prematurely.

Purpose Statement

The purpose of this study will be to examine the success rates of students with a 2.6 to 2.99 high school GPA at participating institutions who were placed in curriculum math courses and supplemental co-requisite courses simultaneously versus those who were placed in curriculum math courses without the co-requisite support. Using an existing Multiple Measures data set from a large, urban community college in North Carolina, the researcher identified propensity score matching as the quantitative design for the study to create two equivalent groups of students matched on the propensity to complete curriculum level mathematics with or without an intervention. The researcher compared math course data from the students who were placed into the curriculum math courses because of the multiple measures policy (with no academic support intervention) with math course data from students who were placed into the curriculum math courses because of the multiple measures policy but had the co-requisite model as an intervention. With this methodology, the researcher was able to control for other variables (i.e. age, demographics, Pell eligibility, etc.) and focus solely on the impact of the intervention itself.

Theoretical Framework

The convergence of two theoretical frameworks provides a context for this study and shapes the researcher's approach to this work: Vincent Tinto's (2002) Theory of Student Departure and Malcolm Knowles' (1984) Theory of Andragogy. In the Theory of Student Departure, Tinto reveals that although the academic and social characteristics students have upon entering an institution impact their retention, persistence and success, the learning environment created by the institution is also critically important to student success. Meaning, the interaction between the student and his/her environment as well as the match between individual motivation, academic ability and his/her academic and social characteristics cause a student to stay or depart.

For the purpose of this study, the researcher examines Tinto's four individual and institutional factors (adjustment, difficulty, isolation, and incongruence) as it relates to student success overall and the impact these factors have on mathematics progression and completion.

To complement the Theory of Student Departure, the researcher explores Knowles' Theory of Andragogy (1984), particularly the four learning environment characteristics that mitigate the impact of adjustment, difficulty, isolation, and incongruence. Knowles maintains that adult students positively engage in their instructional experience if four characteristics are evident: a) the curriculum material is relevant to their personal or career goals; b) the instructional environment is experiential, not just memorization; c) the instructional environment accommodates many different student backgrounds and learning styles; and d) the students are involved in the planning and evaluation of their instruction. If the instructional experience has some of these elements, Knowles believes that the student will overcome the adjustment, difficulty, isolation, and incongruence experienced in an unfamiliar college setting, persist through challenging courses, and ultimately remain at the institution.

Whereas Tinto focuses on student and institutional factors that impact students' ability to be successful in college from one perspective, Knowles emphasizes the importance of the instructional environment that lead to student persistence from another. They both explore the internal and external motivators that lead to student retention and success, and thereby provide an interesting context for understanding the impact of co-requisite study skills courses on at-risk students within high-risk mathematics courses.

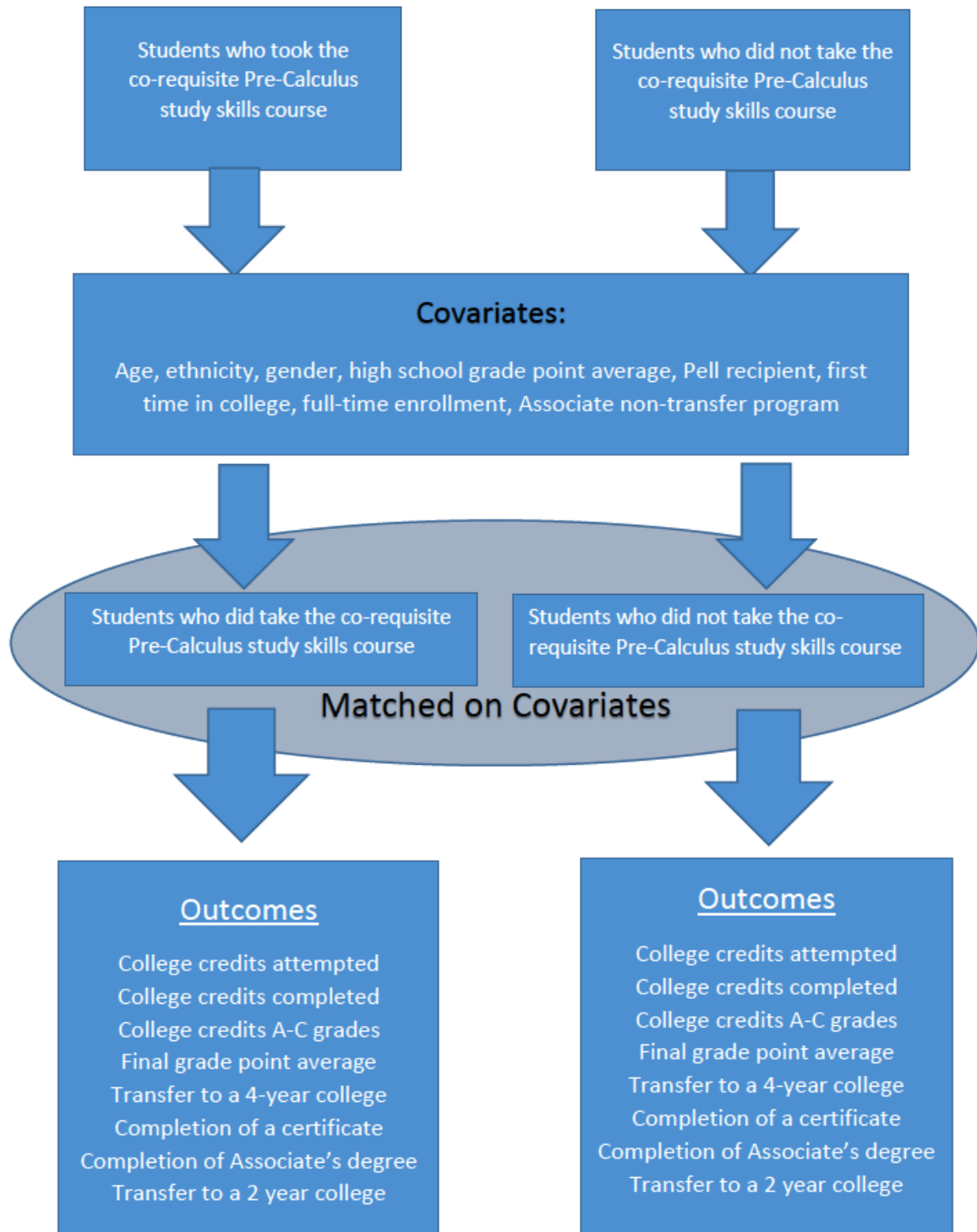


Figure 1. Conceptual Framework for Student Success in Mathematics

Research Questions

The questions that served as the foundation for this study include:

Research Question 1: What are the demographics and academic characteristics of the two groups (those with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course and those that did not participate in the co-requisite study skills course) in 2014-2016?

Research Question 2: Is there a difference in demographics and academic characteristics of the students with a high school GPA of 2.6-2.99 who participated in and did not participate in the co-requisite study skills course?

Research Question 3: After propensity score matching, is there a difference in demographics and academic characteristics of the two study groups?

Research Question 4: After propensity score matching, is there a difference in college level outcomes between students with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course versus those who chose not to do so?

Assumptions and Limitations

“Since community colleges have open door admissions policies that allow little control over the characteristics of students who enroll at their institutions, the best opportunities for serving lie in policies or programs that can mitigate these individual student level effects” (Sullivan, 2010). Most often, such programs or policies, Hodara and Jaggars (2014) state, result in community colleges experimenting with acceleration strategies in an effort to improve outcomes for developmental education students. One such acceleration strategy, which pairs a college-level math course with a co-requisite study skills course, is designed to improve the success rates of developmental students; however, as a relatively new research area to examine, it has its limitations. For one, research suggests that learning communities promote engagement

and strong relationships among students and faculty (Engstrom & Tinto, 2008; Kuh, 2008); yet, the literature on learning communities, specifically for developmental students, is sparse (Visher, Schneider, Wathington, & Collado, 2010). Moreover, there is conflicting evidence about the effectiveness of accelerated programs (Edgecombe, 2011), and some studies have found positive outcomes, while others have identified methodological weaknesses (Daniel, 2000). For example, in a study that examined an accelerated model at the City University of New York community colleges, Hodara and Jaggars (2014) found that “accelerating students through developmental education in shorter sequences results in greater access to college-level coursework and long-term success, but may have consequences for student performance in college-level coursework” (p. 246).

Definition of Key Terms

The following definitions of terms are used for this study:

Adjustment. The ability to successfully transition to a new and more challenging environment.

(Saret, 2016; Tinto, 1993)

Acceleration. Practices and programs that decrease the time for remediation. Can include modularization, co-requisite enrollment in college-level courses or compressed course designs. (Edgecombe, 2011; Hern, 2012; Hodara & Jaggars, 2014)

College ready. A popular term to identify incoming college students who have scored high enough on placement tests or have demonstrated through their high school GPA no need for developmental courses. (Bailey, Jaggars, & Jenkins, 2015)

Combined Course Library. A list of courses and course descriptions of all courses that community colleges in North Carolina may teach. Colleges must use these course descriptions when offering any of these courses, and may not offer courses that are not in the CCL without approval. (NCCCS, 2015)

Co-requisite. Enrolling in two complimentary courses simultaneously. Placing students into introductory college-level courses and providing additional instruction through mandatory companion classes, lab sessions, or other learning supports (Edgecombe, 2011; Hern, 2012)

Course Completion. Course completion means that the student completed the course or did not withdraw from the course.

Credits—Attempted. The total number of credits a student was enrolled in at the 10% census date.

Credits—Completed. The total number of credits associated with a course in which the student did not withdraw.

Credits—Completed A–C. The total number of credits associated with an official grade of C or better.

Cut scores. The lowest score on a test used for classification, or placement, or other purpose. (Bettinger & Long, 2005; Calcagno et al., 2008)

Developmental education. Courses, typically in English, mathematics, or reading, with content below college level. Remedial and developmental are often used interchangeably. (Bettinger & Long, 2009; Boylan, 2009; Boylan & Saxon, 1999; Roueche & Roueche, 1999)

Difficulty. The struggles many students encounter when required to meet the minimum standards of a college level curriculum. (Saret, 2016; Tinto, 1993)

Gatekeeper courses. First year college-level courses, typically in English and mathematics, which are high-risk courses to complete for program persistence. (Hayward & Willett, 2014; Roksa et al., 2009)

Incongruence. The lack of fit between the needs, interests and preferences of the student and that of the institution. (Saret, 2016; Tinto, 1993)

Isolation. A phenomenon where students who have similarities with other members of the college are still unable to make meaningful connections with groups within the institution. (Saret, 2016; Tinto, 1993)

Learning community. Cohort-type of arrangement where students are purposely grouped within a set of courses and/or study groups. (Visher et al, 2010; Zhao & Kuh, 2004; Tinto et al., 1994)

Mainstreaming. Accelerated pathways when developmental students take college level coursework simultaneously. (Bailey et al., 2016)

Mandatory assessment. Mandatory assessment means that all students are required to take a college placement test. In fall 2008, the NCCCS implemented mandatory assessment practices system-wide. Colleges are allowed to make exceptions including using SAT or ACT scores as a proxy for placement testing. (Hughes & Scott-Clayton, 2011; Horn et al., 2009; Pascarella & Terenzini, 2005)

Mandatory placement. Colleges that require students who test into developmental courses to enroll in those courses are said to have mandatory placement. In 2007, the NCCCS implemented mandatory placement practices system-wide. (Hodara et al., 2012; Huneycutt, 2010; Morante, 2012; Ngo & Melguizo, 2016; Saxon & Morante, 2014)

Multiple Measures. Using other sources of data beyond the placement tests, particularly high school information, as a means of determining college readiness and placement. (Bailey, Jaggars, & Jenkins, 2015; Ngo & Kwon, 2015; NCCCS, 2015)

Pass rates. The percent of students at each institution who enrolled in a gatekeeper mathematics course in a particular term and who completed the course with a grade of “C” or better. (Huneycutt, 2010)

Persistence. Used to describe whether a student stays in college beyond a given term. (Huneycutt, 2010; Saret, 2016; Tinto, 1997)

Placement tests. Tests designed to determine an appropriate level of courses for enrollment. (Bailey, 2009; Barnett & Reddy, 2017; Belfield & Crosta, 2012; Bueschel, 2009; Morante, 2012; Saxon & Morante, 2014;)

Propensity Score Matching. A technique used to create two selected groups whose members have matching data markers such as gender, age, or education level that allows for improved group comparisons. (Frye, 2016)

Retention. Most often used to describe whether a student has remained enrolled in college within an academic term although the term may refer to the student remaining enrolled within an academic year or until graduation or transfer. (Huneycutt, 2010; Saret, 2016; Tinto, 1993)

Transfer. Transfer to 4-year institution before credential completion. (Bowen, 2018)

Unknown. Students who did not remain at the college – whereabouts unclear. (Bowen, 2018)

Summary

Chapter One explained the importance of increased success in mathematics courses as it is a significant barrier to retention and completion in many academic programs. Research studies indicate that students who do not do well in mathematics often do not persist in their college goals

and are hindered in their ability to attain better jobs or transfer to another institution. Some of the ways community colleges are attempting to combat this issue are by using high school GPA to determine college readiness for curriculum level mathematics courses while implementing co-requisite academic support.

Chapter Two will examine the existing literature and provide a foundation for the use of two theoretical frameworks that shape the approach to this study: Tinto's Theory of Student Departure and Knowles' Theory of Andragogy. In detail, the chapter will consider the importance of both theories, one on retention and the other on adult learning, to understanding the unique challenges adult learners face when completing a high-risk mathematics course. The benefits of using co-requisite instruction as a means of offering academic support in such a high-risk environment will be explored and the need for alternative placement methods, beyond placement tests, will be discussed. Chapter Three will describe in greater detail the methods that will be used to determine the effectiveness of this co-requisite model and whether this strategy increased the success rates at a large urban community college in North Carolina.

CHAPTER TWO: LITERATURE REVIEW

The beginning of Chapter Two introduces two theoretical perspectives on the retention and learning of post-secondary students that guide the researcher's approach to this study: Tinto's Theory of Student Departure and Knowles' Theory of Andragogy. For the purpose of this research design, the interrelatedness of these two theories is explored and the resulting model that combines elements of both is presented.

The subsequent sections of Chapter Two review the literature on issues within developmental education, particularly as it relates to assessment and placement, readiness, and completion of developmental mathematics courses. The challenges of college remediation as it relates to success in gatekeeper courses are examined and the residual impact on persistence in programs of study are explored. The following factors are discussed in depth as a result: the introduction of accelerated math pathways and the creation of academically integrated learning communities that combine key aspects from both Tinto's and Knowles' frameworks for post-secondary learners.

Introduction to Theories

In the Theory of Student Departure, Tinto (1993) maintains that the academic and social environment created in higher education institutions influence students' willingness to stay or depart, thereby impacting their retention, persistence and success. Maruyama (2012) puts it another way: "Tinto's model of student departure examines interactions of individual and institutional characteristics related to academic and social integration and college completion" (p. 253). Tinto was not alone in exploring the concept of academic and social integration and its subsequent impact on student persistence and success. Astin (1984, 1993) and Bean (1990) also attempted to explain the concept of academic and social integration and its

impact on student engagement, by examining background influences (Bean) and input-output-environmental factors (Astin). However, identifying ways institutions can enhance integration for all students, particularly underrepresented or non-traditional populations, is not a simple solution. And although recent studies, such as those by Zhao and Kuh (2004) and Kuh et al. (2005), explore institutional data that attempt to answer why students depart from college prematurely, using that data to inform decisions that address the root cause of attrition for non-traditional students continues to be critical and relevant for community colleges.

While the researcher discovered other theorists who attempt to explain student departures from an institutional perspective (Astin, 1993; Bean, 1990; Russo, 1994; Zhao & Kuh, 2004), Tinto's work was a compelling framework for this study as it explores the integration of individual and institutional factors that impact student retention and departure, paying particular attention to four factors: adjustment, difficulty, isolation, and incongruence. Tinto maintains that institutions must share the responsibility for student persistence and be "committed to the development of supportive social and educational communities in which all students are integrated as competent members" (p. 147).

In this study, Tinto's four factors that impact student retention and departure are juxtaposed against Knowles' adult learning theory and raise an interesting question about the correlation between academic and social integration and an adult learning environment. In Knowles' Theory of Andragogy (1984), he specifies the importance of creating an educational experience for adult learners that compel them to persist at an institution, listing specific characteristics that must be present in the classroom related to instructional design and learning experiences to engage non-traditional students. Both of these theories, examining what is

essential for retention at an institutional and individual level, shape the researcher's lens in this study and are used to inform the researcher's work.

Tinto's Theoretical Framework on Student Departure

In the Theory of Student Departure, Tinto describes the phenomenon of student departure from an institutional and individual perspective, before he attempts to analyze it. According to Fike and Fike (2008), "this theory suggests that students' progress through stages as they make the transition from being a first time in college (FTIC) student to being a mature student. These stages are influenced by academic and social integration; working together, both lead to the student's decision to remain in or to leave college" (p. 69). In his description of institutional rates of departure, Tinto explains that "two year colleges as a group exhibit considerably higher rates of institutional departure than do four year institutions, colleges, and universities" (p. 31). Laura Saret (2016), in an article that relates Tinto's retention theory to community college students says, "Students do not begin a college course with the intention of dropping out before the end of the term, but many do" (p. 1). Because of this, this study examines the individual and institutional factors that lead to student departure, and conversely, those experiences that cause students to remain.

From an individual level, Tinto identifies two main attributes that are considered the primary roots of student departure: "intention and commitment" (p. 39). Intention indicates a student's focus on a particular academic or occupational goal while commitment references a student's motivation to meet that goal. Although Tinto recognizes the role that individual characteristics play on student departure, he also stresses the importance of examining the interactional experiences students have within the institution itself. To explain the outcomes of

these interactional experiences on an institutional level, Tinto identifies four factors which appear to influence student departure: “adjustment, difficulty, incongruence, and isolation” (p. 47).

Adjustment, or the ability to successfully transition to a new and more challenging environment, is commonly experienced among many college students. According to Saret (2016), first generation college students need additional assistance in navigating the “college culture” and learning the rules of the “college game.” This adjustment is even more challenging among underrepresented student populations because, as Fike and Fike (2008) mention, “community colleges are more likely to enroll higher percentages of minority students than the university” (p. 70). Statistics from the U.S. Department of Education, National Center for Education Statistics (2001) indicate that minority students are less likely to be successful if their parents did not attend college as they most often will not receive the same support and guidance during their college career as their white counterparts.

And while an adjustment period is necessary and poses its own set of challenges, the term ‘difficulty’ refers to the unique academic struggles many students encounter when required to meet the minimum standards of a college level curriculum. With more students requiring remediation, difficulty is a phenomenon that many community college students face when persisting through their academic program of study. However, for community college students who are first generation college students, from minority backgrounds, or otherwise ill equipped for the academic demands of college, the period of adjustment may be even more difficult. In a multi-institutional, four-year study of the impact of learning communities on the success of academically underprepared, predominantly low-income students, Engstrom and Tinto (2008) state that “low-income students are more likely to begin higher education academically under-prepared than those from more-affluent backgrounds” (p. 47). Tinto attributes this variance to the

unique characteristics of community college students who, among other variables, have had more challenges during their high school careers and are deemed, as a whole, less academically prepared for the rigor of college studies. Fike and Fike (2008) state that “because of the open-door policy, underprepared students are encouraged to enroll in a community college, where they can take advantage of developmental education, or remedial, courses” (p. 70).

And although offering academic support is a resource for underprepared students, it is not without its challenges. McCabe (2000) stresses that “ninety five percent of community colleges offer remedial education courses. Forty-one percent of entering community college students and twenty nine percent of all entering college students are underprepared in at least one of the basic skills of reading, writing, and/or mathematics” (p. 4). With so many community college students requiring some type of academic support, the road to college completion is more daunting, which in turn, may result in higher attrition rates in community colleges.

While Tinto defines ‘difficulty’ as the academic challenges students encounter when pursuing a post-secondary education, he describes ‘incongruence’ as the lack of fit between the needs, interests and preferences of the student and that of the institution (p. 53). If a perception exists of being mismatched or misaligned with the institution, students will not connect with the academic setting or programming offered and/or feel that further attendance is not in their best interest. According to Pascarella and Terenzini (1991), the more intensely students are engaged and involved in their own education, the more likely they are to do well, be satisfied with their educational experience, and stay in school. Ensuring that the educational content is relevant to their professional goals and aligns with their career needs increases adult learners’ perception of the value of their education and motivates them to continue in their studies.

And finally, Tinto explains isolation, although associated with incongruence, as a phenomenon where students who have similarities with other members of the college are still unable to make meaningful connections with groups within the institution (p. 64). Unlike traditional students, adult learners do not live on campus, most likely work full-time, and may be married with children. Consequently, their involvement in activities outside of the classroom is limited, while their participation in other communities (family and work) is much more extended. In their study, Ashar and Skenes (1993) applied Tinto's student departure model to non-traditional students and found that the "classes that were socially integrated and smaller were better able to retain their students than the less socially integrated and larger-sized classes" (p. 90). Based on Tinto's work and their research findings, it is evident that a major factor of retaining adult learners in educational programs is not only providing the support needed for the academic rigor, but also creating a welcoming social environment in which the learning occurs.

Tinto presents these four phenomena (adjustment, difficulty, isolation, and incongruence) as a means of examining the reasons why students choose to stay or depart from an institution. Recognizing that there are individual and institutional factors that contribute to these four areas, Tinto emphasizes the important role that an institution must play in creating an environment that minimizes these root causes of attrition, and instead, encourages students to persist to meet their academic and professional goals.

Knowles' Theoretical Framework on Andragogy as a Foil to Tinto's Framework on Student Departure

Knowles' extensive work on andragogy, the art and science of helping adults learn, presents an interesting foil to Tinto's work on student departure as it offers an approach to connecting with non-traditional or adult learners inside the classroom that may mitigate the

impact of adjustment, difficulty, incongruence, and isolation. Knowles (1984) emphasizes that adult learners have needs that differ from those identified in the K-12 population and thus require a different approach to teaching and learning. Kiely et al. (2004) state that “the central dynamic work in Knowles’ andragogical equation is that adults are a unique breed of learner and require a different instructional strategy from traditional teacher-centered and subject focused pedagogy” (p. 20). The learning environment that appeals to adult learners, Knowles explains, must recognize that “adults have a) a need to be self-directing, although they may be dependent in particular temporary situations, b) a rich experiential knowledge base that is an ideal resource for learning, c) a readiness to learn when the instruction is connected to real-life tasks or problems, and d) a desire to have cooperative learning communities and projects that foster mutual trust and helpfulness, not competitiveness and judgmentalism” (p. 44-45). Engstrom and Tinto (2008) reinforce the responsibility institutions have in creating an environment where adults can learn and state: “To promote greater student success, institutions have to take seriously the notion that the failure of students to thrive in college lies not just in the students but also in the ways they construct the environments in which they ask students to learn. Institutions have to believe that all students, not just some, have the ability to succeed under the right set of conditions—and that it is their responsibility to construct those conditions” (p. 50).

In Knowles’ research, adults have to re-orient themselves in the learning process by making a shift in their thinking as a passive learner who may not have been perceived as smart or capable in their early educational career to one of self-directed and an active contributor to their educational experience. He asserts that some adult learners may have K-12 classroom memories so rife with images of failure and disrespect that they create a barrier to engaging in their adult learning activities, thereby reinforcing Tinto’s premise that an adjustment is necessary in order to

successfully assimilate in the academic community. To support this adjustment, Knowles maintains that the learning environment should promote a “psychological climate which causes adults to feel accepted, respected, and supported; in which there is exists a spirit of mutuality between teachers and students as joint inquirers; in which there is freedom of expression without fear of punishment or ridicule” (p.47). Kiely et al. (2004) surmise that “because adults bring a diverse combination of knowledge, experience, and independence to the classroom, adult educators should work to ensure that adult learners participate as much as possible in the content delivery, and evaluation of curricula within a climate of mutual respect” (p. 21).

Engstrom and Tinto (2008) also found that the learning community model reinforced this feeling of mutual respect and peer support, creating a positive climate for adults to learn. In interviewing a cohort of students, they noted that students perceived the learning community experience as different “because people got to know each other, trusted and respected each other, took risks, and really participated” (p. 4). This type of peer support, inherent in many linked groups in community colleges, reinforces the value of shared learning and support, and the importance of cooperative groups in college courses, particularly those that are more challenging for adult learners. In a study by Triesman (1992), the value of peer support in college calculus learning communities was noted and the collaborative pedagogy embedded within many of these cohorts was highlighted. Engstrom and Tinto (2008) also recounted a story about a learning community of calculus students and shared that “their experiences demonstrated how teaching and learning roles can move between peers and instructors when students are encouraged to take more responsibility for their learning and see their peers and themselves as sources of knowledge” (p. 48).

Another critical argument that Knowles explores is the assumption that adults can learn, even if they have had academic and social challenges as students within a K-12 environment. In his andragogical framework, Knowles defines learning as an “internal process that acknowledges, values, and incorporates the experiences of the adult learners rather than an external process driven by the subject matter expertise of the teacher alone” (p. 58). When Tinto presents the difficulty students experience in transitioning to the academic rigor of college, the faculty member is emphasized as the subject matter expert in the classroom and the sole owner of the curriculum content; in contrast, Knowles positions the teacher as one who facilitates learning and demonstrates a respect and appreciation for the knowledge adult learners bring to the academic environment. He argues that because there are superior conditions of learning and teaching for non-traditional students, some learning environments are more conducive to growth and development than others. Such a learning environment, Knowles argues, has the following characteristics: “it is relevant to the goals of the adult learner; it allows the learner to actively participate in the learning process; and it incorporates the experiences of the learner as resources for learning” (pp. 57-58). Creating such positive learning conditions, Knowles asserts, validates the contributions of the adult learner, encourages an adult learner to find value in his/her educational experience, and minimizes some of the difficulty experienced during the post-secondary transition.

Knowles also reasons that the way learning experiences are designed impact how adult learners perceive the value, meaning and relevance of the educational programming, a factor that Tinto found may lead to incongruence within the college setting. Knowles is not alone. Other researchers have emphasized that the organization of the classroom environment, including the interactions between the teacher and the students, may not only influence the student learning outcomes, but may also factor in on a student’s decision to leave or remain at a certain college or

university (Braxton, Bray, & Berger, 2000; Braxton, Hirschy, & McClendon, 2004; Braxton & McClendon, 2001; Braxton, Milem, & Sullivan, 2000; Braxton & Mundy, 2002; Nora, Cabrera, Hagedorn, & Pascarella, 1996; Tinto, 1997, 2007). In Hern's 2010 study of the Chabot College accelerated developmental model, she confirmed that "when developmental students aren't successful in their classes, the core issue is often not their ability to handle the course content, but when they encounter a difficult task, or receive critical feedback, or start to feel hopeless about their prospect of success, many of them will disengage, withdraw effort, and even disappear from class" (p. 64).

Because adult learners have a need to solve a problem or determine relevance when they enter a class or program of study, Knowles maintains that they must discern why a particular area of focus is important to their personal and professional goals and quickly find the connections between the programming, the curriculum and their desired outcome. The teacher, rather than assuming those connections will be automatically evident to the adult learner, must work with the student to identify where the intersectionality between the curriculum and their personal/professional goals occurs and ensure that the needs of the adult learner is being met throughout the instruction. When faculty work together to construct a seamless learning environment where course content is integrated, students find relevance in the material that makes it easier to learn (Engstrom & Tinto, 2008).

And finally, Knowles addresses the isolation experienced by adult learners in Tinto's theory by recommending a learning environment "characterized by physical comfort, conducive to interaction, and accepting of differences" (p. 57). If students experience a campus culture that is very different from their own, they will have difficulty becoming connected, a situation in which many minority and first-generation students find themselves when embarking on a college

experience (Rendon, Jalomo, & Nora, 1998; Saret, 2016). In Knowles' model, the teacher sets an inclusive tone by creating a classroom community of learners who engage in shared, cooperative activities that emphasize interdependence while allowing for the strengths of each adult learner to emerge. For many students, the college classroom may be the only place where involvement may arise. Students who interact with their teachers develop a support network and are more likely to persist in classes (Tinto, Russo, & Stephanie, 1994).

This ongoing interaction reduces the sense of isolation experienced by most adult learners and fosters relationships of mutual trust and helpfulness among the learning community. "It is the people who come face-to-face with students on a regular basis who provide the positive growth experiences for students that enable them to identify their goals and talents and learn how to put them to use. The caring attitude of college personnel is viewed as the most potent retention force on a campus" (Noel, Levitz, & Saluri, 1985, p. 17). Saret (2016) surmises that when "students' goals and commitments interact with college experiences in ways that don't facilitate students becoming academically and socially connected, they are not likely to persist. Faculty must create learning opportunities that enable students to make those connections" (p. 1). Tinto (2009) would agree: "Students are more likely to succeed in settings that actively involve them with faculty and staff members and student peers. Nowhere is such involvement more important than in the classroom. Active involvement of students in learning activities in and around the classroom, especially with other students, is critical to student retention and graduation" (p. 1).

Knowles, through extensive research of the adult learner, discovers that an instructional environment with certain characteristics fosters the deep and meaningful learning that encourages adults to remain at an institution. Those andragogical characteristics are academic programming that is relevant to the goals of the adult learner; allows the learner to actively participate in the

learning process; and incorporates the experiences of the learner as resources for learning. All of these factors create an environment that validates the contribution of the non-traditional student and help mitigate the four variables mentioned in Tinto's work.

The Relevance of the Two Selected Theories to this Study

According to Weissman, Bulakowski, and Jumiski (1997), students who need remediation in reading, writing and mathematics should be required to complete their developmental education program before beginning college level courses. However, Tinto (2002) argues that developmental education programs do not retain students unless the courses and programs are connected to the curriculum, and even more so, to the competencies students need to be successful within that curriculum. As such, he promotes the use of learning communities as a model where students can receive academic support and persist through their college level course work simultaneously. In their research, Engstrom and Tinto (2008) discovered that students felt the same. They believed that they made more substantial progress in both basic skills and content knowledge because they combined the two courses while earning college credits, making them feel like "real" college students and not a marginalized group on campus. In a later article, Tinto (2009) stressed that "support, especially academic support, must be carefully aligned with and connected to the classrooms in which students seek to learn. Alignment, such as that which occurs in supplemental-instruction and basic-skills learning communities, makes it easier for students to apply that support to the immediate task of succeeding in the class in which they are enrolled" (p. 1).

In this study, the researcher examines the impact of such a reform, particularly a co-requisite mathematics model, on the success rates of adult learners in a high-risk mathematics course at one large, urban community college. Bailey et al. (2015) state that these types of

reforms “seek to immediately engage all students in challenging college-level material that is relevant to their program of study, while building students’ foundational academic skills along the way” (p. 119). In a study within the mathematics department at the University of Toledo that also explored the value of a math study skills course, Lewis (2014) found that “students who took the math study skills class seriously were able to bridge the gap in their unpreparedness compared to other students taking the same entry level course but not enrolled in the co-requisite math study skills course” (p. 1). Alternative methods of teaching mathematics, such as through learning communities, have been shown to increase student time devoted to developmental math thus providing extra time to master mathematical concepts (Berry, 2003).

The research in this study explores the value of such a course within one large community college in North Carolina. The adult learner population in the sample, deemed at risk for college level work based on their high school GPA of 2.6-2.99, were provided an intervention (in this case, the accompanying study skills class) to ensure their persistence and completion of this high-risk mathematics course. To capture both the academic and social challenges experienced by the adult learner population and the subsequent elements of the co-requisite mathematics model intervention, the researcher created a conceptual framework that juxtaposes Knowles’ andragogical research, evident in the co-requisite mathematics design, with Tinto’s four roots of student departure, factors that frequently cause flight among students who require remediation and academic support.

The co-requisite model, that pairs a challenging gatekeeper mathematics course with a related study skills support course, mirrors a community of support that allows students to problem solve together while learning important study strategies to address the more difficult topics. This model was designed to positively impact the retention and success rates of non-

traditional students through adopting some of the characteristics of Knowles' andragogical framework, and in so doing, control for the stimuli that may inadvertently lead to student departure in Tinto's framework.

The model that combines the research of both Tinto and Knowles in an andragogical approach to adult student departure is below:

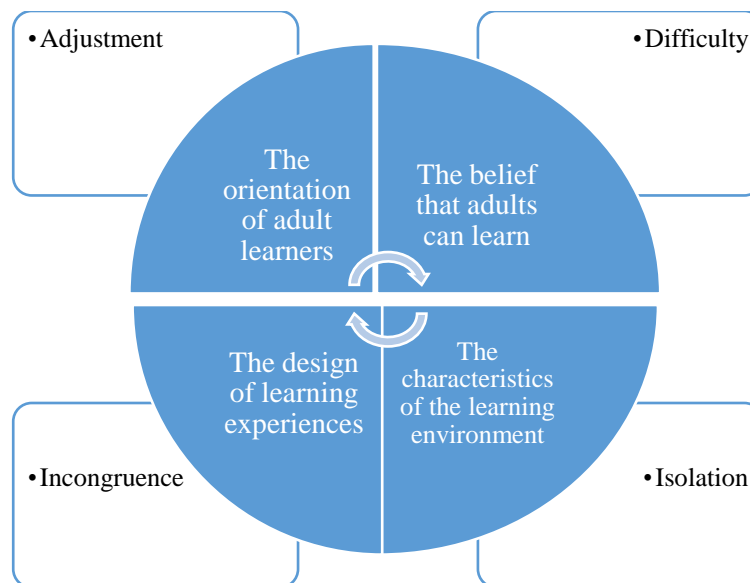


Figure 2. Wilson's Model of an Andragogical Approach to Adult Student Departure¹

Literature on Issues within Developmental Education

Boylan and Saxon (1999) state in their article on “What Works in Remedial Education” that “remedial courses have been a fixture in American community colleges since these institutions first appeared in postsecondary education at the turn of the 20th century” (p. 1). While the open-door philosophy of community colleges has provided access to many students who may

¹ Inner circle of model includes the four characteristics of Knowles' (1984) framework of andragogy: a) the orientation of adult learners (p. 46), b) the belief that adults can learn (p. 55), c) the design of learning experiences (p. 54), and d) the characteristics of learning environment (p. 57).

not have been granted a postsecondary education, it has not been without its challenges (Horn et al., 2009). In a study by Crisp and Delgado (2014) exploring the impact of developmental education on community college persistence and transfer, “propensity score matching results reveal that students who enroll in developmental courses are systematically different from community college students who do not remediate in gender, ethnicity, first-generation status, academic preparation and experiences during high school, and delayed college entry” (p. 99).

Greater access to such a varied and diverse population equated to a lack of college readiness in many college students and spurred the need for some type of academic support (Culp, 2005). “Along with the commitment to access, community colleges also wish to maintain high standards,” a goal that many believe is compromised by the increasing number of students who require remediation (Perin, 2006, p. 340). Bailey et al. (2015) would agree. “In Community College Research Center studies of developmental education across several community college systems, researchers found that faculty and administrators often assume that, without the screening mechanism of placement testing, the academic quality of introductory college-level courses would be threatened” (Bailey et al., 2015, p. 123). By limiting access to college-level courses while students complete their sequence, institutions believe they can support access while maintaining academic rigor (Hodara, Jaggars, & Karp, 2012). However, because many students never complete their developmental coursework, only a small portion ever enroll in college-level mathematics (Bailey, Jeong, & Cho, 2010).

In embracing the open-door policy, community colleges now grapple with the reality of a significant number of students who begin a remediation sequence but never finish. According to Bailey et al. (2010), over 50% of community college students enroll in at least one developmental education course during their tenure in college. Attewell et al. (2006) explained this trend in even

more detail in the National Educational Longitudinal Study (NELS: 88). In the college transcript data sample, they found that 58% of community college students took at least one developmental course, 44% took between one and three developmental courses, and 14% took more than three remedial courses. And of the students taking developmental coursework, less than one-third persist to graduation (Adelman, 2007; Hagedorn, 2009). According to Ngo and Kwon (2014), “although developmental courses can serve as necessary and helpful stepping stones to college success, they can also delay access to critical gateway courses necessary for degree attainment or transfer to 4-year colleges” (p. 443). Hern agrees, stating “We will never increase completion rates for College Math—and therefore increase the numbers of students becoming eligible for transfer and degrees— unless we shrink the length of our developmental sequences” (p. 62).

Assessment and Placement Issues

The low percentage of students completing developmental coursework before entering college-level classes caused researchers to examine the number of students placed into remediation, to question the accuracy of the placement test overall, and to consider non-cognitive measures to determine college readiness (Bailey, 2009; Bailey, Jeong, & Cho, 2010; Barnett & Reddy, 2017; Belfield & Crosta, 2012; Bettinger & Long, 2009; Perin, 2006). According to Mekonnen (2010) and Morante (2012), the purpose of a placement test is to assist entering students by assessing their prior knowledge and placing them into appropriate courses that fit their achievement level. Hughes and Scott-Clayton (2011) indicate that placement tests are commonly used in community colleges across the country to make course placement decisions, whether it is into remedial or curriculum level coursework, and students are often placed into math or English courses based on the results of this one singular assessment.

When using a placement test to ascertain college readiness, most community colleges have found that at least two thirds of entering students are not academically prepared to engage in college level work in at least one subject area, leading to more students taking coursework that does not accumulate in credit hours or degree completion (Bailey, 2009). Bailey (2008) and Cohen (2008) reinforce that the completion of a high school diploma does not always ensure that students are prepared for the demands of a college curriculum, and many students lack the necessary prerequisite knowledge needed for mathematics and/or English courses.

While the use of placement tests vary on the state and local level, a large number of states have mandated the use of common assessments, seeing placement policies as a mechanism for increasing student success (Collins, 2008; Maxwell, 1997; McCabe, 2000; Roueche & Roueche, 1999). Some researchers believe that an ideal model of remediation would assess entering students for academic preparedness and then place them in remedial courses if their skills are below college level (Boylan, Bliss, & Bonham, 1997; Roueche & Roueche, 1999). The underlying presumption is that students, when placed into a developmental or curriculum level course based on the placement test results, will be successful at the prescribed level and persist to the next (Haehl, 2007).

However, recent studies on assessment and placement from the Community College Research Center challenged this assumption and caused states and colleges across the country to consider using multiple measures or other measures to inform placement decisions (Belfield & Crosta, 2012; Hughes & Scott-Clayton, 2011; Ngo & Kwon, 2015; Scott-Clayton, 2012). In the last ten years, researchers have presented evidence that placement tests have low predictive validity, identifying weak correlations between placement test scores, students' course passing rates, and college grades (Armstrong 2001; Jenkins et al., 2009; Medhanie et al., 2012). Belfield

and Crosta (2012) found that the positive, but weak association between placement test scores and college GPA disappeared after controlling for high school GPA, suggesting that high school information may offer more useful measures for course placement. Akin to other studies, Ngo and Kwon (2015) found that “high school GPA is highly predictive of college persistence and success” (p. 445), indicating that both cognitive and non-cognitive measures are viable factors in evaluating college readiness in entering students. Belfield and Crosta (2012) also confirmed that high school GPA is useful in predicting many aspects of college performance and had a strong correlation with college GPA and credit hour accumulation.

Although the scan of the literature by Ngo and Kwan (2015) revealed “that there is relatively scant evidence showing that using these measures to make course placement decisions would be beneficial” (p. 447), their analysis of data from the Los Angeles Community College District proved to the contrary. It indicated that students who were placed in curriculum level math courses due to multiple measures (i.e. high school GPA and prior math background) performed no differently in pass rates and credit completion than their peers with higher placement test scores. Hence, their findings suggest that community colleges can improve placement accuracy in remedial math courses and increase access to curriculum level math courses by implementing multiple measures in the assessment and placement process (Ngo & Kwon, 2014).

Mathematics Placement: Challenges and Opportunities

As stated by Scott-Clayton et al. (2014), approximately one-fourth of all community college students are inappropriately placed in mathematics courses by placement tests. Yet, Engelbrecht and Harding (2015) assert that first year mathematics courses provide the foundation for the knowledge necessary to progress through many programs of study. Based on their

findings, students who experience difficulty completing their mathematics courses are more likely to withdraw from college, thereby negatively impacting the retention and graduation rates of the institution. Bahr (2010) reveals the significant challenges that students encounter in persisting through and successfully completing these courses, and consequently, the low percentage of developmental students who satisfactorily complete the subsequent gatekeeper mathematics course. In a recent analysis by the Community College Research Center, Bailey et al. (2015) discovered that of the 150,000 students from community colleges across the country, “30 percent of students referred to developmental math completed their sequence within three years, and only 16 percent completed a first college-level math course” (p. 121). These disparities point to an alarming trend: of the small percentage of students who finish their mathematics remediation, very few successfully enter or even exit their subsequent college level mathematics courses (Attewell et al., 2006).

To address this issue, some institutions implemented learning communities that combine high-risk mathematics courses and academic support, blending the best of Tinto and Knowles’ research, to ensure that students will not just begin the mathematics pathway, but finish. Engstrom and Tinto (2008) learned that students’ involvement in learning communities eradicated “fears and anxieties, developed their sense of belonging, increased their confidence in their abilities, enhanced their self-esteem, and reinforced their belief that they were on the “right track” (p. 49). Because students were more academically and socially engaged, they were more likely to be successful both inside and outside of the classroom.

Summary

Success in mathematics has been a consistent challenge for many community college students to overcome. The developmental mathematics sequences, rather than improving college

readiness and promoting greater success in college completion, have hindered many students from progressing in their college coursework and led to increased attrition and low completion rates. Based on studies from the CCRC, high school GPA was determined to be a better predictor of college readiness, and as a result, many colleges decided to adopt multiple measures in an attempt to minimize the negative impact of remediation. Although implementing multiple measures reduced the number of students enrolled in developmental mathematics, it also led to unanticipated outcomes: a group of students who needed co-requisite support while taking curriculum level mathematics courses. Bailey et al. (2016) concede that there is “no single “magic bullet.” Many interventions may be more effective in combination than if implemented alone. For example, the evidence suggests that the bundling of interventions is associated with relatively strong effects in developmental students’ outcomes. These bundles of interventions can include some combination of full-time enrollment, enhanced advising, tutoring, accelerated coursework, a cohort model, or student financial incentives, among others.” (p. 10). Research from Tinto and Knowles suggest strategies on improving the educational environment and support systems for adult learners to mitigate the unique challenges many of them encounter in high risk mathematics courses, and when doing so, purport it should lead to increased persistence and success overall.

In the subsequent chapter, I will outline a research methodology for exploring the effectiveness of a co-requisite study skills course for one particular curriculum mathematics class that was deemed high risk for many students. Using propensity score matching, the outcomes of two groups of students were compared: one that has been exposed to the co-requisite study skills course and another without the prescriptive academic support.

CHAPTER THREE: METHODS

According to Caliendo and Kopeinig (2008), “propensity score matching (PSM) has become a popular approach to estimate causal treatment effects and is widely applied ... in very diverse fields of study” (p. 31). Because it allows for improved group comparisons, propensity score matching has become more common in post-secondary institutions to evaluate student outcomes in learning and retention as revealed by academic variables and student demographics (Frye, 2016). Frye and Bartlett (2017) state that “there are several types of approaches available for institutional researchers when creating matched groups for analyses” (p. 44). In this case, the researcher compared a new student cohort group exposed to an intervention (treatment) to a historical past group not exposed to the intervention (control).

Frye (2016) states that propensity score matching is a technique used to create randomly selected groups whose members have matching data markers such as gender, age, or education level in an effort to minimize the bias from non-randomized samples that can occur in the selection of database subsets for comparative analysis. “Propensity scores range from 0.0 to 1.0 and these scores are used to match students from a large database of a potential comparison group to produce a comparison group that is similar to the study group on the significant covariates. Propensity scores must be assessed to ensure that the distributions are similar across the two groups and that outliers are not present in the propensity scores that could affect the analysis” (Frye, 2014, p. 104).

Marts (2016) and Rojewski et al. (2010) concur that when creating a propensity score matching model, it is important to select the appropriate covariates. The researcher, then, strategically selected the covariates to create the propensity score for this study, including the demographic variables of ethnicity, age, and gender. The other covariates considered in this

research are program type, Pell recipient, enrollment status, first time in college, high school grade point average, and retention from first to second semester. All of these variables, accessible in the Multiple Measures data set, are appropriate as covariates to sort the group membership of the student population.

Advantages and Limitations of Propensity Score Matching

There are many advantages to propensity score matching, particularly in a higher education setting (Frye, 2016; Frye & Bartlett, 2017). One advantage is that PSM simulates an experimental design that matches the students in the treatment group who received the intervention with those who did not get the intervention, either through choice or by design. This quantitative approach is an effective methodology as PSM controls for selection bias, i.e. age, demographics, and other factors so that only the results of the intervention is evident. Frye (2016) states that “without the use of propensity score matching, it can be difficult to determine if group differences are based on the treatment or on pre-existing differences in group characteristics” (p. 6). PSM controls for this variance and allows the researcher to narrow down the specific reasons for the outcomes. Frye and Bartlett (2017) concur that “PSM is a technique designed to simulate an experimental design, controlling for selection bias, and creating almost equivalent experimental and control groups on key indicators” (p. 43).

Another advantage of using PSM is that it allows the researcher to analyze data that has been gathered in the past, tracking the performance of a cohort over time. Because this study is using information from an existing Multiple Measures data set, PSM is a viable approach that controls for pre-existing conditions and isolates the impact of the treatment on the population sampled. As explained by Rosenbaum and Rubin (1984), propensity scores indicate the

“conditional probability of a person being in one condition rather than another given a set of observed covariates used to predict a person’s condition” (p. 4).

Although the advantages of PSM are noteworthy, the limitations of this approach must also be considered. Some of them include the bias that may result from variables not included in the data set, the need for a larger control group versus treatment group, the reduced sample size that occurs as a result of non-matches, and the sample size limitations for logistic regression (Frye, 2016).

Study Population

This study was conducted at one of the largest urban, multi-campus community colleges in the southern region of North Carolina, serving 60,000 students annually. The institution offers more than 300 degree, diploma, and certificate programs, customized corporate training, market-focused continuing education, and hundreds of special interest classes. The population for this project included students who were enrolled during the 2013, 2014, and 2016 academic years and were deemed college ready for curriculum level mathematics based on their 2.6-2.99 high school GPA. Students in the sample varied in their ethnicity, age, gender, financial aid status, states, countries, sexual identities, religious beliefs, economic status, class rank, and other demographics.

Using a subset from the Multiple Measures data set, the researcher studied two groups: students in MAT 171 (Pre-Calculus) who had a 2.6-2.99 high school GPA and did not use the co-requisite study skills course (because it was not yet available) with students in MAT 171 (Pre-Calculus) who had a 2.6-2.99 high school GPA and did enroll in the co-requisite study skills course. The control group included students from two fall terms to ensure an adequate sample size: fall 2013 and fall 2014. These students enrolled in the MAT 171 in fall 2013 and fall 2014 with a 2.6-2.99 GPA before the implementation of MAT 001P (the co-requisite Pre-Calculus

study skills course). The treatment group included students from fall 2016 who also had a 2.6-2.99 high school GPA but did enroll in the MAT 171 (Pre-Calculus) and MAT 001P (Pre-Calculus Study Skills) courses simultaneously. The purpose of this study was to determine if there was a difference in outcomes of grade point average, credits earned, credentials earned, rate of transfer, and retention between these two groups.

Dataset Construction

Each term, the Institutional Research Office at the community college that provided the data for this study gathers observational data that is used in institutional planning and research. This data serves a variety of purposes: federal and state reporting requirements, ad hoc data requests, and other institutional research needs like grant requirements, cohort tracking, and program reviews. Although the Multiple Measure data files were created as part of the institution's participation in Completion by Design, the data was compiled to address the research questions in this particular study. Using the student information system (Colleague) to extract the data, the Institutional Research Office collected the data, merged the files, created a research ID to anonymize the students so they could not be linked back to the college records, and assembled the data set for sorting and review. An inquiry was made to Central Piedmont Community College regarding the accessibility of data to determine the feasibility of the proposed study. In order to gain permission to use the data for the research, a formal request was processed through the institution's IRB committee and was approved on December 17, 2016 (Appendix C).

Recoding Variables

Table 1 below shows the different variables that were included in this study. The covariates and outcome variables were listed and each variable was identified by type. Categorical and continuous variables were identified, and dummy variables were created for

categorical variables such as ethnicity and gender. The researcher used a similar method for coding all of the categorical variables.

Table 1

Variable Types and Coding Schemes

Variable Name	Type	Coding	
Enrolled in Co-requisite Study Skills	Categorical	1 = Yes	0 = No
American Indian	Dummy	1 = Yes	0 = Caucasian
Asian American	Dummy	1 = Yes	0 = Caucasian
African American	Dummy	1 = Yes	0 = Caucasian
Native Hawaiian	Dummy	1 = Yes	0 = Caucasian
Hispanic	Dummy	1 = Yes	0 = Caucasian
Non-Resident Alien	Dummy	1 = Yes	0 = Caucasian
Two or More Races	Dummy	1 = Yes	0 = Caucasian
Other Race	Dummy	1 = Yes	0 = Caucasian
Male Gender	Dummy	1 = Yes	0 = Female
Non-Transfer Program	Dummy	1 = Yes	0 = Associate
Age	Continuous		
Pell Recipient	Dummy	1 = Yes	0 = No
Full-Time Enrollment	Dummy	1 = Yes	0 = No
First Time in College	Dummy	1 = Yes	0 = No
High School GPA	Continuous	1 = Yes	0 = No

Reporting Pre-Matched Differences on Outcome, Demographic, and Academic Variables

Prior to matching, the differences between the outcome, demographic, and academic variables are reported for the control and treatment groups. The following are used to describe the groups: means, standard deviations, frequency, and percent. Using t-tests and chi-square, the

researcher will explore if differences existed between the two groups and effect sizes were reported (Tables 2 and 3). Frye and Bartlett (2017) explained that “since matching on the propensity scores creates two equivalent groups on average, t-tests can subsequently be used to measure program impact” (p. 43).

Table 2 lists the continuous and categorical outcomes used to differentiate the two groups: math and college credits attempted and/or earned, credentials earned, rate of transfer, and retention.

Table 2

Outcomes Variable Types and Coding Schemes

Variable Name	Type
College Credits Attempted	Continuous
College Credits Completed	Continuous
College Credits A–C Grades	Continuous
College Math Credits Attempted	Continuous
College Math Credits Completed	Continuous
College Math Credits A–C Grades	Continuous
Co-requisite Study Skills Attempted	Continuous
Co-requisite Study Skills Completed	Continuous
Completion of Associate Degree	Categorical
Completion of Certificate	Categorical
Transfer to a 4 Year College	Categorical
Completion of Diploma	Categorical
Not Enrolled	Categorical

Table 3

Statistical Tests Used to Examine Co-requisite Impact on Student Academic Outcomes

Outcomes	Variable Types	Test
Final Grade Point Average	Continuous	<i>t</i> -test
Transfer to 4-year College	Dummy	chi-square
Completion of Certificate	Dummy	chi-square
Completion of Associate's	Dummy	chi-square
Transfer to 2-year College	Dummy	chi-square

Table 3 reflects the t-tests and chi-square tests used to explore if differences existed between the two groups in the following outcomes: final grade point average, transfer to a 4-year or 2-year college, or completion of a certificate or Associate's degree.

Data Analysis

According to Marts (2016), propensity score matching is a multivariate statistical technique that involves multiple steps in the examination. Calienda and Kopeinig (2008) explain the step by step process in completing propensity score matching. More recently, Frye and Bartlett (2017) list six essential steps to PSM: data pre-screening, covariate identification, propensity score estimation, matching of propensity scores, determination of matching success, and presentation of results (Figure 3).

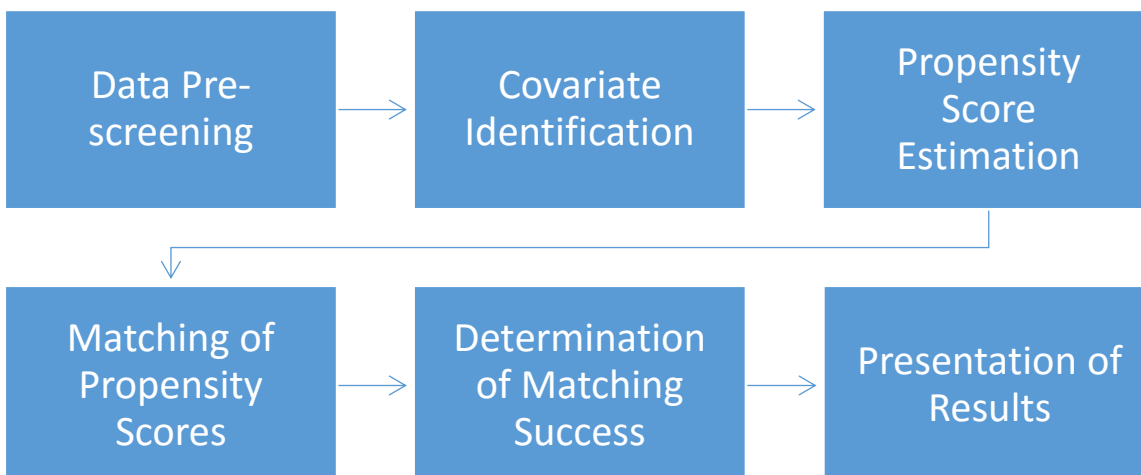


Figure 3: Steps for Propensity Score Matching

The six steps are explained in further detail below.

Step 1: Data Pre-screening

Since propensity matching is a multivariate statistical technique, typical data pre-screening procedures should be utilized. Datasets should be checked for missing data, univariate and multivariate outliers, before proceeding with propensity score matching. Data should be screened for collinearity (variables correlated with each other) and addressed (Frye, 2016; Marts, 2016).

Step 2: Covariate Identification

The use of logistic regression allows researchers to identify the covariates, or the independent variables with the highest degree of influence on the dependent variable. Logistic regression is a variation of multiple regression, which uses quantitative independent variables to explain or predict a quantitative dependent variable. Logistic regression is used in situations where the dependent variable is categorical instead of quantitative. Logistic regression uses multiple quantitative independent variables to predict the probability of group membership or the categorical dependent variable (Frye, 2016; Marts, 2016). In this study, the covariates were

examined to see which variables best predicted student success in Pre-Calculus courses. The data available supported the selection of identification variables.

Step 3: Propensity Score Estimation

The covariates identified in the logistic regression are combined into a single summary propensity score whose value ranges between 0.0 and 1.0 (Frye, 2016; Marts, 2016). The researcher checked the propensity scores for balance across groups and identified any outliers. Also, the researcher had to check the covariates prior to matching across the groups (Frye, 2016).

Step 4: Propensity Score Matching

Propensity score matching scores are used to select a control group that matches the treatment group on a group of specified covariates. There are a number of algorithms that can be used to match propensity scores (Frye, 2016; Marts, 2016). Nearest neighbor matching or greedy matching are most common algorithms (Frye, 2016).

Step 5: Determination of Matching Success

In propensity score matching, the researcher uses t-tests or X^2 tests based on the data type to assess pre-post covariates of treatment and control groups. If propensity score matching has been successful, there should be no significant difference (5% threshold) between the groups on the initial covariates (Frye, 2016; Marts, 2016).

Step 6: Presentation of Results

The researcher assesses the outcomes on the matched data sets and compares treatment to non-treatment groups across outcome variables using t-tests or chi-square according to the data types (Frye, 2016). Once the data is analyzed, the researcher is able to share the results and conclusions with others in the field to make generalizations about the effect of the intervention on the treatment group.

Expected Findings

The study population of the existing dataset consists of fall 2013/14 and fall 2016 new student cohorts at one large community college. Student outcomes and progression were tracked for five years, and the data set included demographics, course completion data, and transfer information available through participation in the Completion by Design Initiative, a project funded by the Bill and Melinda Gates Foundation. Although the raw data extracted included individual college data provided to Completion by Design, one college data set will be analyzed as a representative sample of the larger population.

The researcher expects that the students will have a definite improvement in student success rates and retention based on the co-requisite study skills model because of the high school GPA placement range of 2.6-2.9, considered a reasonable metric for entry placement in some literature. Controlling for selection bias, the researcher predicts a slight increase in success rates and retention within all demographic groups based on the targeted study skills and learning community environment and anticipates that a course traditionally considered a ‘gatekeeper’ will now be classified as a ‘gateway’ course to completion.

Summary

Chapter 3 described the research methodology appropriate to the nature of this analysis (i.e. propensity score matching) and why this quantitative approach was appropriate for this study. In the next chapter, the researcher will examine the findings of student variance as explanatory variables in curriculum math success outcomes and student progression at the community college and explore whether co-requisite remediation was effective in mitigating the impact of high school GPA as a placement diagnostic in high-risk math courses.

CHAPTER FOUR: RESULTS

Propensity score matching was the quantitative methodology used to determine whether there was a difference in student success across two groups of students enrolled at a large, urban community college in North Carolina. Using an existing Multiple Measures data set, the researcher examined academic outcomes (retention, completion, and transfer) to ascertain the impact of co-requisite mathematics remediation on various outcome variables. The results of this research study are shared in Chapter 4 and include a summary of the study, a description of the data analysis, a presentation of the outcomes with the corresponding findings, and a conclusion.

Rosenbaum and Rubin (1984) state that propensity scores reveal the “conditional probability of a person being in one condition rather than another given a set of observed covariates used to predict a person’s condition” (p. 4). In this study, the researcher compared the math course data from two equivalent groups: Group A - the control group - were the students placed into the curriculum math courses (with no academic support intervention), and Group B – the treatment group - were the students who were placed into the curriculum math courses (with co-requisite remediation) because of the multiple measures policy. Using propensity score matching, the researcher examined the effects of co-requisite mathematics remediation through the use of these two comparable groups (the control and treatment groups) to more fully understand the impact of this intervention based on the Multiple Measure Placement Policy utilized by community colleges within North Carolina. This was accomplished by calculating a propensity score for each case and then matching students from the control and treatment groups to each other based on their propensity score.

Data Analysis

The early steps of the data analysis involved examining the student record data for missing values and outliers to verify that the data were complete. Initially, the researcher intended to use student data from the Fall 2013 semester, but since the credit hours in the MAT171 Pre-Calculus course changed from 3 credit hours to 4 credit hours between the Fall 2013 term and Fall 2014 term, all the cohort metrics would have been impacted. As such, the researcher determined that using the data that included the 4 credit hour Pre-Calculus courses only, beginning with the Fall 2014 term, yielded a large enough sample size ($n=946$) in the control group for more consistent and reliable results. These 946 students, comprising the final data sample, included students from the 2014-2016 college dataset with an official grade in the MAT 171 Pre-Calculus course. Of the 946 students, there were 231 students in the dataset originally identified as enrolled in MAT 001, the co-requisite study skills course. However, the researcher omitted 9 students from the treatment group, leaving 222 students, because even though the 9 students were enrolled in the study skills course, they did not enroll in MAT171 simultaneously.

In this final analytical sample of 946 students, the group dependent variable was coded as one for the students enrolled in the MAT 001 co-requisite study skills course (the treatment group) and zero for students who did not enroll in a support course at all (the control group). Table 4 provides an overview of the demographics and covariates for the control group prior to matching while Table 5 offers a synopsis of the demographics and covariates for the treatment group prior to matching. Examining the descriptive statistics of the covariates revealed that the treatment group who enrolled in the co-requisite study skills course varied from the control group in the sample.

In Tables 4 and 5, for example, a comparative analysis of control and treatment groups of the descriptive covariates revealed interesting observations for the researcher. The African American students (16.91%, $n = 160$) and Hispanic students (14.06%, $n = 133$) in the control group outnumbered those in the co-requisite study skills group (19.37%, $n = 43$) and (19.82%, $n = 44$) respectively. The non-transfer program category, which refers to students not enrolled in a transfer program, indicated that there were significantly more students pursuing non-transfer degrees (26.00%, $n = 246$) in the control group than in the co-requisite study skills group (12.61%, $n = 28$). Students enrolled in co-requisite study skills courses were less represented among male students (51.80%, $n = 115$) than control group students (57.82%, $n = 547$). The number of full-time students who did not enroll in a co-requisite study skills course (66.17%, $n = 626$) was greater than the number of full-time students who did enroll (85.14%, $n = 189$). Likewise, the number of students classified as first time in college (FTIC) in the control group (52.43%, $n = 496$) exceeded the number of students enrolled in the co-requisite study skills course (62.16%, $n = 138$). Pell-recipient students were of a higher percentage in the treatment group (48.65%, $n = 108$) than in the control group (41.75%, $n = 395$). And the average age of the students enrolled in the co-requisite study skills course was 18 years versus 20 years in the control group. Tables 4 and 5 provided a comprehensive review of the descriptive statistics in the sample population prior to propensity score matching and created an important baseline for further analysis.

Table 4

Descriptive Statistics of Control Group (N=946), Prior to Propensity Score Matching

Variable	Level	<i>N</i>	%
Asian	No	886	93.66
	Yes	60	6.34
African American	No	786	83.09
	Yes	160	16.91
Hispanic	No	813	85.94
	Yes	133	14.06
Non-Resident Alien	No	882	93.23
	Yes	64	6.77
Multi-Racial	No	910	96.20
	Yes	36	3.80
Unknown Race/Ethnicity	No	909	96.09
	Yes	37	3.91
White	No	492	52.01
	Yes	454	47.99
Non-Transfer Program	No	700	74.00
	Yes	246	26.00
Gender	Female	399	42.18
	Male	547	57.82
FTIC Flag	No	450	47.57
	Yes	496	52.43
Pell Recipient	No	551	58.25
	Yes	395	41.75
Full-Time	No	320	33.83
	Yes	626	66.17
		Mean	SD
Final Age		20.074	4.360

Table 5

Descriptive Statistics of Treatment Group (N=222), Prior to Propensity Score Matching

Variable	Level	<i>N</i>	%
Asian	No	205	92.34
	Yes	17	7.66
African American	No	179	80.63
	Yes	43	19.37
Hispanic	No	178	80.18
	Yes	44	19.82
Non-Resident Alien	No	212	95.50
	Yes	10	4.50
Multi-Racial	No	207	93.20
	Yes	15	6.80
Unknown Race/Ethnicity	No	218	98.20
	Yes	4	1.80
White	No	133	59.91
	Yes	89	40.09
Non-Transfer Program	No	194	87.39
	Yes	28	12.61
Gender	Female	107	48.20
	Male	115	51.80
FTIC Flag	No	84	37.84
	Yes	138	62.16
Pell Recipient	No	114	51.35
	Yes	108	48.65
Full-Time	No	33	14.86
	Yes	189	85.14
		Mean	SD
Final Age		18.909	1.239

After the data exploration was completed, the researcher began the data analysis procedure by running logit analysis on specific independent variables in SPSS and testing propensity scores to be used in the final model. The logit analysis was conducted in SPSS using the propensity score matching function in order to determine if balanced propensity scores occurred.

Ranging from 0.0 to 1.0, propensity scores were used to match students from a file of one possible comparison group to produce another comparison group that is akin to the study group on the identified covariates. (Marts, 2016) To ensure that there were no outliers that could impact the analysis, the researcher assessed the propensity scores to ensure that the distributions were comparable across the two groups. Frye (2016) states that propensity score matching is a technique used to create randomly selected groups whose members have matching data markers such as gender, age, or education level in an effort to minimize the bias from non-randomized samples that can occur in the selection of database subsets for comparative analysis. “Propensity scores range from 0.0 to 1.0 and these scores are used to match students from a large database of a potential comparison group to produce a comparison group that is similar to the study group on the significant covariates. Propensity scores must be assessed to ensure that the distributions are similar across the two groups and that outliers are not present in the propensity scores that could affect the analysis” (Frye, 2014, p. 104).

Additionally, the researcher employed a minima-maxima technique of common support, which is used, according to Caliendo and Kopeinig (2008), to promote reasonable estimates of study effects and more balanced matches. “Common support implied that if propensity scores fell in the range of 0.14-0.94 for the study group and in the range of 0.09-0.79 for the comparison group, then the region of common support using minima-maxima criteria was defined as the interval 0.14-0.79” (Marts, 2016, p. 79). It was critical that the minimum and maximum value of

the propensity score in one group was also present in the other (Rojewski et al., 2010). Utilizing the SPSS function, the researcher was able to determine the tolerance level of common support of 0.05 in order to create sufficient overlap between the propensity scores in both groups (Leuven & Sianesi, 2003). As stated by Gelman and Hill (2007), through matching, cases can be eliminated so that the remaining cases show good balance and overlap. Once the propensity scores were determined, the researcher used SPSS to generate the matched groups for the final analysis.

Rojewski et al. (2010) affirm that logistic regression analyses yield significant independent variables that predict membership in the two groups of study before the propensity score matching. An analysis of Nagelkerke R-Squared, chi-squared, beta coefficients, and independent variables with p value $< .05$ indicate significant predictors and covariates were retained in the model and ultimately were used to determine which independent variables were connected with the dependent variable – enrolling or not enrolling in a co-requisite study skills course (Hair et al., 2010).

In Table 6, logistic regression results reveal that the overall model of three predictors (enrolled in a non-transfer degree, enrolled full-time, and age) were statistically reliable in predicting membership in the dependent variable, in this case, enrollment in the co-requisite study skills course (-2 Log Likelihood = 1052.348; chi-squared = 83.71, $p < .001$; Nagelkerke R Squared = 0.111). The model correctly classified 81% of the cases and explained 11.1% of the variance in the dependent variable. Regression coefficients and Wald statistics also confirmed that these three variables significantly predicted group membership in the dependent variable.

Table 6

Logistic Regression Results Predicting Membership in Treatment Group Before Propensity Score Matching

Independent Variable	β	S.E.	Wald	<i>df</i>	Sig.	Exp(β)	% Magnitude
Asian	0.327	0.315	1.078	1.000	0.299	1.386	39%
African American	0.242	0.227	1.134	1.000	0.287	1.274	27%
Hispanic	0.402	0.226	3.166	1.000	0.075	1.495	50%
Non-Resident							
Alien	-0.177	0.373	0.226	1.000	0.635	0.838	-16%
Multi-Racial	0.665	0.344	3.743	1.000	0.053	1.945	95%
Unknown	-0.726	0.550	1.741	1.000	0.187	0.484	-52%
Non-Transfer	-0.819	0.221	13.779***	1.000	0.000	0.441	-56%
Male	-0.173	0.158	1.200	1.000	0.273	0.841	-16%
FTIC	0.000	0.179	0.000	1.000	0.999	1.000	0.0%
Pell Recipient	0.008	0.174	0.002	1.000	0.965	1.008	.08%
Age Final	-0.138	0.043	10.185**	1.000	0.001	0.871	-13%
Full-Time	1.024	0.209	23.968***	1.000	0.000	2.785	179%
Constant	0.527	0.876	0.363	1.000	0.547	1.694	

Note. Chi-Square = 83.712 $p < .001$, -2 LL 1052.348, Nagelkerke R Square 0.111, 81% Predicted Correctly
*** $p < .001$, ** $p < .01$, * $p < .05$

To further determine if there was a difference in the categorical variables of the two study groups, the researcher conducted a series of chi-square tests on the following populations: Asian, African American, Hispanic, Non-Resident Alien, Multi-Racial, Non-Transfer, Gender, First

Time in College (FTIC), Pell Recipient, Full-Time, and White. The chi-square tests denoted goodness of fit between the observed values and those expected in theory to see if they were related. The researcher also used a Fisher's Exact Test, a standard practice to validate the results, for the unknown race/ethnicity category as expected frequencies in two chi-square cells were less than 5 (within the 'No' categories). And t-tests were employed to examine Age as it is classified as a continuous variable.

According to chi-square tests of Asian Race/Ethnicity, there were no significant differences before and after matching, as indicated by $p > .05$ in Tables 7 and 8. In Table 7 prior to propensity score matching, $p = 0.477$, while in Table 8, $p = 0.728$ after propensity score matching.

Table 7

Chi-Square Analysis of Asian Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Asian	<i>N</i>	%	<i>N</i>	%
No	886	93.66	205	92.34
Yes	60	6.34	17	7.66
Total	946		222	

Note. Chi-Square = 0.505, $df = 1$, $p = 0.477$, $\phi = .021$, $p = 0.477$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 8

Chi-Square Analysis of Asian Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
Asian	<i>N</i>	%	<i>N</i>	%
No	201	91.40	203	92.30
Yes	19	8.60	17	7.70
Total	220	100.00%	220	100.00%

Note. Chi-Square = 0.121, $df = 1$, $p = 0.728$, $\phi = -0.017$, $p = 0.728$

*** $p < .001$, ** $p < .01$, * $p < .05$

Based on the chi-square tests of African American Race/Ethnicity, there were also no significant differences before and after matching, as indicated by $p > .05$ in Tables 9 and 10. Before matching, $p = 0.385$ in Table 9, and after matching, $p = 0.556$ in Table 10.

Table 9

Chi-Square Analysis of African American Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
African American	<i>N</i>	%	<i>N</i>	%
No	786	83.09	179	80.63
Yes	160	16.91	43	19.37
Total	946		222	

Note. Chi-Square = 0.755, $df = 1$, $p = 0.385$, $\phi = 0.025$, $p = 0.385$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 10

Chi-Square Analysis of African American Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
African American	<i>N</i>	%	<i>N</i>	%
No	172	78.20	177	80.50
Yes	48	21.80	43	19.50
Total	220	100.00%	220	100.00%

Note. Chi-Square = 0.346, $df = 1$, $p = 0.556$, $\phi = -0.028$, $p = 0.556$

*** $p < .001$, ** $p < .01$, * $p < .05$

As evident in the chi-square tests of Hispanic Race/Ethnicity, there was a significant difference prior to matching, but there were no significant differences after matching, as indicated by $p > .05$ in Table 11 and $p = 0.172$ in Table 12.

Table 11

Chi-Square Analysis of Hispanic Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Hispanic	<i>N</i>	%	<i>N</i>	%
No	813	85.94	178	80.18
Yes	133	14.06	44	19.82
Total	946		222	

Note. Chi-Square = 4.641*, $df = 1$, $p < .05$, $\phi = 0.063$, $p < .05$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 12

Chi-Square Analysis of Hispanic Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
Hispanic	<i>N</i>	%	<i>N</i>	%
No	164	74.50	176	80.00
Yes	56	25.50	44	20.00
Total	220	100.00%	220	100.00%

Note. Chi-Square = 1.864, $df = 1$, $p = 0.172$, $\phi = -0.065$, $p = 0.172$

*** $p < .001$, ** $p < .01$, * $p < .05$

Upon examining the variables of Non-Resident Alien Race/Ethnicity, there were no significant differences before and after matching, as indicated by $p = 0.213$ and $p = 0.418$ respectively. (See Tables 13 and 14).

Table 13

Chi-Square Analysis of Non-Resident Alien Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Non-Resident Alien	<i>N</i>	%	<i>N</i>	%
No	882	93.23	212	95.50
Yes	64	6.77	10	4.50
Total	946		222	

Note. Chi-Square = 1.549, $df = 1$, $p = 0.213$, $\phi = -0.036$, $p = 0.213$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 14

Chi-Square Analysis of Non-Resident Alien Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
Non-Resident Alien	<i>N</i>	%	<i>N</i>	%
No	213	96.80	210	95.50
Yes	7	3.20	10	4.50
Total	220	100.00%	220	100.00%

Note. Chi-Square = 0.551, $df = 1$, $p = 0.458$, $\phi = 0.035$, $p = 0.458$

*** $p < .001$, ** $p < .01$, * $p < .05$

Likewise, upon examining the variable Multi-Racial Race/Ethnicity, there were no statistically significant differences before and after matching, as indicated by $p = 0.053$ and $p = 0.564$ respectively (See Tables 15 and 16).

Table 15

Chi-Square Analysis of Multi-Racial Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Multi-Racial	<i>N</i>	%	<i>N</i>	%
No	910	96.20	207	93.20
Yes	36	3.80	15	6.80
Total	946		222	

Note. Chi-Square 3.750, $df = 1$, $p = 0.053$, $\phi = 0.057$, $p = 0.053$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 16

Chi-Square Analysis of Multi-Racial Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
Multi-Racial	<i>N</i>	%	<i>N</i>	%
No	204	92.70	207	94.10
Yes	16	7.30	13	5.90
Total	220	100.00%	220	100.00%

Note. Chi-Square = 0.332, $df = 1$, $p = 0.564$, $\phi = -.027$, $p = 0.564$

*** $p < .001$, ** $p < .01$, * $p < .05$

Again, results before and after matching for the Unknown Race/Ethnicity variable were not statistically significant (See Tables 17 and 18). For a chi-square test to be successful, the numbers must be large enough in each entry (5 or more). As expected frequencies in two chi-square cells were less than 5, a Fisher's Exact Test for the unknown race/ethnicity category was conducted after matching.

Table 17

Chi-Square Analysis of Unknown Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Unknown	<i>N</i>	%	<i>N</i>	%
No	909	96.09	218	98.20
Yes	37	3.91	4	1.80
Total	946		222	

Note. Chi-Square 2.362, $df = 1$, $p = 0.124$, $\phi = 0.025$, $p = 0.124$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 18

Fisher's Exact Test of Unknown Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
Unknown	<i>N</i>	%	<i>N</i>	%
No	219	99.50	216	98.20
Yes	1	0.50	4	1.80
Total	220	100.00%	220	100.00%

Note. Fisher's Exact Test $p = 0.372$

2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.

Fisher's Exact Test Employed

*** $p < .001$, ** $p < .01$, * $p < .05$

When examining the Non-Transfer Program, there were statistically significant differences prior to propensity score matching as seen in $p < .001$ versus after in $p < .084$ (See Tables 19 and 20).

Table 19

Chi-Square Analysis of Non-Transfer Program Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Non-Transfer	<i>N</i>	%	<i>N</i>	%
No	700	74.00	194	87.39
Yes	246	26.00	28	12.61
Total	946		222	

Note. Chi-Square = 17.958***, $df = 1$, $p < .001$, $\phi = -.124$, $p < .001$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 20

Chi-Square Analysis of Non-Transfer Program Post Propensity Score Matching

	Group			
	Control		Treatment	
Non-Transfer	<i>N</i>	%	<i>N</i>	%
No	203	92.30%	192	87.30%
Yes	17	7.70%	28	12.70%
Total	220	100.00%	220	100.00%

Note. Chi-Square = 2.995, $df = 1$, $p = 0.084$, $\phi = 0.083$, $p = 0.084$

*** $p < .001$, ** $p < .01$, * $p < .05$

The Gender variable, however, reflected no statistically significant differences in the control group versus the treatment group results (See $p = 0.103$ in Table 21 and $p = 0.567$ in Table 22).

Table 21

Chi-Square Analysis of Gender Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Gender	<i>N</i>	%	<i>N</i>	%
Female	399	42.18	107	48.20
Male	547	57.82	115	51.80
Total	946		222	

Note. Chi-Square = 2.654, $df = 1$, $p = 0.103$, $\phi = -.048$, $p = 0.103$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 22

Chi-Square Analysis of Gender Post Propensity Score Matching

	Group			
	Control		Treatment	
Gender	<i>N</i>	%	<i>N</i>	%
Female	111	50.50%	105	47.70%
Male	109	49.50%	115	52.30%
Total	220	100.00%	220	100.00%

Note. Chi-Square = 0.327, $df = 1$, $p = 0.567$, $\phi = 0.027$, $p = 0.567$

*** $p < .001$, ** $p < .01$, * $p < .05$

For the First Time in College variable, there were statistically significant results as evident by the $p < .01$ before matching and the $p < .001$ after matching (See Tables 23 and 24).

Table 23

Chi-Square Analysis of FTIC Flag Prior to Propensity Score Matching

	Group			
	Control		Treatment	
FTIC Flag	<i>N</i>	%	<i>N</i>	%
No	450	47.57	84	37.84
Yes	496	52.43	138	62.16
Total	946		222	

Note. Chi-Square = 6.861**, $df = 1$, $p < 0.01$, $\phi = 0.077$, $p < 0.01$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 24

Chi-Square Analysis of FTIC Flag Post Propensity Score Matching

	Group			
	Control		Treatment	
FTIC Flag	<i>N</i>	%	<i>N</i>	%
No	157	71.40%	84	38.20%
Yes	63	28.60%	136	61.80%
Total	220	100.00%	220	100.00%

Note. Chi-Square = 48.891***, $df = 1$, $p < 0.001$, $\phi = 0.333$, $p < 0.001$

*** $p < .001$, ** $p < .01$, * $p < .05$

When evaluating the Pell Recipient status of the control and treatment groups before and after matching, there were no statistically significant differences prior to matching ($p = 0.062$), but there were statistically significant differences post matching ($p < .05$) (See Tables 25 and 26).

Table 25

Chi-Square Analysis of Pell Recipient Status Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Pell Recipient	<i>N</i>	%	<i>N</i>	%
No	551	58.25	114	51.35
Yes	395	41.75	108	48.65
Total	946		222	

Note. Chi-Square = 3.485, $df = 1$, $p = 0.062$, $\phi = 0.055$, $p = 0.062$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 26

Chi-Square Analysis of Pell Recipient Post Propensity Score Matching

	Group			
	Control		Treatment	
Pell Recipient	<i>N</i>	%	<i>N</i>	%
No	87	39.50%	113	51.40%
Yes	133	60.50%	107	48.60%
Total	220	100.00%	220	100.00%

Note. Chi-Square = 6.197*, $df = 1$, $p < 0.05$, $\phi = -0.119$, $p < 0.05$

*** $p < .001$, ** $p < .01$, * $p < .05$

For the Full Time variable, there were statistically significant results as evident by the $p < .001$ before matching and the $p < .05$ after matching (See Tables 27 and 28).

Table 27

Chi-Square Analysis of Full-Time Prior to Propensity Score Matching

	Group			
	Control		Treatment	
Full-Time	<i>N</i>	%	<i>N</i>	%
No	320	33.83	33	14.86
Yes	626	66.17	189	85.14
Total	946		222	

Note. Chi-Square = 30.656***, $df = 1$, $p < 0.001$, $\phi = 0.162$, $p < 0.001$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 28

Chi-Square Analysis of Full-Time Post Propensity Score Matching

	Group			
	Control		Treatment	
Full-Time	<i>N</i>	%	<i>N</i>	%
No	17	7.70%	33	15.00%
Yes	203	92.30%	187	85.00%
Total	220	100.00%	220	100.00%

Note. Chi-Square = 5.776*, $df = 1$, $p < 0.05$, $\phi = -0.115$, $p < 0.05$

*** $p < .001$, ** $p < .01$, * $p < .05$

Analyzing the White Race/Ethnicity variable showed that there were statistically significant differences prior to propensity score matching $p < .05$ versus after $p < .114$ (See Tables 29 and 30).

Table 29

Chi-Square Analysis of White Race/Ethnicity Prior to Propensity Score Matching

	Group			
	Control		Treatment	
White	<i>N</i>	%	<i>N</i>	%
No	492	52.01	133	59.91
Yes	454	47.99	89	40.09
Total	946		222	

Note. Chi-Square = 4.513*, $df = 1$, $p < 0.05$, $\phi = -.062$, $p < 0.05$

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 30

Chi-Square Analysis of White Race/Ethnicity Post Propensity Score Matching

	Group			
	Control		Treatment	
White	<i>N</i>	%	<i>N</i>	%
No	147	66.80	131	59.50
Yes	73	33.20	89	40.50
Total	220	100.00%	220	100.00%

Note. Chi-Square = 2.501, $df = 1$, $p = 0.114$, $\phi = 0.075$, $p = 0.114$

*** $p < .001$, ** $p < .01$, * $p < .05$

T-tests were performed on the continuous variable of Age, both prior to and post propensity score matching, to assess whether the means of the two groups were statistically different from each other. Results indicated there was a statistical difference of $p < .01$ before matching and $p < .05$ after matching. Because a statistically significant result may have a weak effect, the researcher also examined the effect size of this particular variable. In this case, the effect size (Cohen's D) for this variable was 0.363 prior to matching and 0.543 after the matching occurred (see Tables 31 and 32), indicating that the size of the difference was not trivial.

Table 31

Results of T-tests Analysis of Final Age, Prior to Propensity Score Matching

	Group				t	p	d
	Control		Treatment				
df	Mean	SD	Mean	SD			
1133	20.074	4.360	18.909	1.239	7.087	< 0.01	0.363

Note. Cohen's $d = M_1 - M_2 / \sigma_{\text{pooled}}$ where $\sigma_{\text{pooled}} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$

Equal variances not assumed

Table 32

Results of T-tests Analysis of Final Age, Post Propensity Score Matching

	Group				t	p	d
	Control		Treatment				
df	Mean	SD	Mean	SD			
438	20.137	2.923	18.918	1.242	5.695	< 0.05	0.543

Note. Cohen's $d = M_1 - M_2 / \sigma_{\text{pooled}}$ where $\sigma_{\text{pooled}} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$

In Tables 33 and 34, the researcher used t-tests to measure the propensity scores before and after the matching. If the propensity score matching is successful, then the propensity scores are balanced between groups and there are no significant statistical differences between the propensity score matching scores after the match. The results in Tables 33 and 34 indicate that the match was successful.

Table 33

Results of T-tests Analysis of Propensity Score, Prior to Propensity Score Matching

<i>df</i>	Group				<i>t</i>	<i>p</i>	<i>d</i>
	Control		Treatment				
	Mean	<i>SD</i>	Mean	<i>SD</i>			
1166	0.176	0.099	0.246	0.099	-9.346	< 0.01	0.707

Note. Cohen's $d = M_1 - M_2 / \sigma_{\text{pooled}}$ where $\sigma_{\text{pooled}} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$

Equal variances not assumed

Table 34

Results of T-tests Analysis of Propensity Score, Post Propensity Score Matching

<i>df</i>	Group				<i>t</i>	<i>p</i>	<i>d</i>
	Control		Treatment				
	Mean	<i>SD</i>	Mean	<i>SD</i>			
438	0.241	0.088	0.241	0.088	-0.028	.978	0.000

Note. Cohen's $d = M_1 - M_2 / \sigma_{\text{pooled}}$ where $\sigma_{\text{pooled}} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$

T-tests were also conducted on the following outcome variables in Table 35: credits attempted, credits completed, credits A-C, Math credits attempted, Math credits completed, and Math credits A-C. The results indicated the p value for each outcome variable, and only the credits attempted variable may be considered statistically significant at $p = .057$; since the remaining variables were all $p > .05$, they were not considered statistically significant (See Table 35). The effect size (Cohen's D) for all of these variables was also small, with the highest value being 0.194 for the Math credits A-C, indicating that the differences were trivial, no matter the statistical significance.

Table 35

Results of T-tests Analyses of Select Outcome Variables, Post Propensity Score Matching

Variable	<i>df</i>	Group				<i>t</i>	<i>p</i>	<i>d</i>
		Control		Treatment				
		Mean	<i>SD</i>	Mean	<i>SD</i>			
Credits Attempted	438	24.940	7.772	26.330	7.596	-1.905	0.057	-0.181
Credits Completed	436	23.150	8.466	24.630	8.132	-1.872	0.062	-0.178
Credits, A-C	393	20.210	8.624	19.090	9.762	1.209	0.228	0.122
Mat Credits Att.	438	6.340	2.686	6.090	2.440	1.041	0.299	0.097
Mat Credits Comp.	413	6.050	2.621	5.840	2.332	0.842	0.400	0.085
Mat Credits, A-C	269	5.910	2.560	5.450	2.165	1.601	0.111	0.194

Note. Cohen's $d = M_1 - M_2 / \sigma_{\text{pooled}}$ where $\sigma_{\text{pooled}} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$

Using chi-square analysis, completion and transfer outcomes were determined in Table 36. The analysis revealed no statistical differences for the control group ($p = 0.401$) and the treatment group ($p = 0.401$), and the p values indicated that the outcomes were not statistically significant.

Table 36

Chi-Square Analyses of Completion Post Propensity Score Matching

	Group			
	Control		Treatment	
Completion	<i>N</i>	%	<i>N</i>	%
Unknown	178	80.90%	178	80.90%
Associate	3	1.40%	7	3.20%
Certificate	0	0.00%	1	0.50%
Transfer*	39	17.70%	34	15.50%
Total	220	100.00%	220	100.00%

Note. * Transfer to 4 year institution before credential completion

Chi-Square = 2.942, $df = 3$, $p = 0.401$, $\phi = 0.082$, $p = 0.401$

Summary

In Chapter 4, the results of the study were revealed using propensity score matching to determine if there was a difference in student success for students enrolled at a large urban community college in North Carolina. The researcher examined different student success outcomes for students who enrolled in the co-requisite study skills course (MAT 001) based on the Multiple Measures placement policy versus those who enrolled in the MAT 171 Pre-Calculus course alone. For this study, student success included retention, completion, or transfer to a four-year institution.

The quantitative approach used by the researcher was an effective methodology as propensity score matching controls for selection bias in such things as participant age, demographics, and other factors so that only the results of the intervention are evident. Frye (2016) states that “without the use of propensity score matching, it can be difficult to determine if group differences are based on the treatment or on pre-existing differences in group characteristics” (p. 6). Propensity score matching controls for this variance, and in this case, allowed the researcher to narrow down the specific reasons for the student success outcomes. The researcher used logistic regression to discover the variables which were statistically reliable for prediction of membership in the dependent variable. Those variables included Asian, African American, Hispanic, Non-Resident Alien, Multi-Racial, Non-Transfer, Gender, First Time in College (FTIC), Pell Recipient, Full-Time, White, Unknown Race, and Age. Of the variables listed, the p values of the chi-square tests and t-tests indicated that Non-Transfer, First Time in College, Full-Time and Age were not independent and, in fact, could be linked to membership in the co-requisite study skills group.

CHAPTER FIVE: CONCLUSIONS, DISCUSSION AND IMPLICATIONS

Within Chapter 5, the researcher expounds on the impact of co-requisite mathematics to include conclusions, a discussion of the results, and implications for future research and practice. Each research question is presented and answered with the corresponding conclusion and discussion. The limitations and delimitations of the study are disclosed as well as implications for future research on the efficacy of the intervention itself.

The primary purpose of this study was to examine whether the co-requisite study skills courses for high risk mathematics courses, particularly MAT 171 (Pre-Calculus), was an effective intervention for students with a high school GPA of 2.6-2.99 versus those who enrolled in the Pre-Calculus course without the academic support. While this study found many resources examining the challenges of developmental education and the hurdles developmental students face in mathematics courses, there were fewer studies that explored the impact of co-requisite remediation on this specific student population, deemed too prepared for developmental courses, but underprepared for high risk mathematics classes. Of the limited research on co-requisite courses, Bailey et al. (2016) found that “accelerated courses that mainstream developmental education students into college level work with contextualization or supplemental instruction help students achieve the goals and outcomes of the college level course assignments” (p. 45). Further, Jaggars et al. (2015) noted that acceleration may promote persistence and academic success because the reduced time in developmental education also reduces the opportunity for external factors, such as work or family responsibilities, to hinder students’ success.

The focus of this study was intended to build upon this research in the literature, beginning with a comprehensive review of the extant literature and including both a theoretical and conceptual framework. The quantitative research methodology selected was propensity score

matching, and its appropriateness for this study, the analysis of data, and the subsequent results were shared. Major findings, limitations and delimitations, and implications for future research are also incorporated.

Conclusions and Discussion

The research questions provided the necessary direction for the study, shaping the data and analysis critical to the work. These four questions focused on the demographic and academic characteristics of the treatment and control groups: those with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course based on the Multiple Measures Placement Policy and those who enrolled in the Pre-Calculus course alone. The findings of the research questions provided an understanding of how co-requisite study skills participation affected student success outcomes of grade point average, transferability, and completion.

Research Question 1

Research Question 1: What are the demographics and academic characteristics of the two groups (those with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course and those that did not participate in the co-requisite study skills course) in 2014-2016? To respond to Research Question 1, the researcher describes the demographics and academic characteristics of the treatment and control groups as a microcosm of the overall student population at a large urban community college in North Carolina from 2014-2016. In the study, the researcher noted 946 students in the overall dataset with 222 of the students identified as participants in the co-requisite study skills course. Both the treatment and control groups consisted of a diverse student population, including full-time, first time in college, and Pell recipient students. Not surprisingly, there was a much larger number of students in non-transfer programs who elected not to enroll in a co-requisite mathematics course than in the treatment

group, most likely because Pre-Calculus is not a requirement in many non-transfer degree programs. Although men represented the greater percentage in the study, it was only by a small margin as there were a similar number of female students in the sample. And finally, white students outnumbered other ethnicities such as African Americans, Hispanics and Asians in the co-requisite mathematics course.

The researcher also noted that the demographics in this study reflected the composition of the institution and its surrounding urban community. The United States Census Bureau affirmed the following composition of the local urban community in 2014-2016: 42% Caucasian, 35% African-American, 13% Hispanic, 6% Asian, and 4% other.

(<https://www.census.gov/quickfacts/fact/table/charlottecitynorthcarolina,US/PST045217>). Men and women were close in number within the surrounding community, and in this case, the percentage of women surpassed the men by a margin of 4%, with 52% overall. When examining the 2014-2016 demographics at the community college itself, the researcher found that the student body composition was comparable: 44% male; 56% female; 44% Caucasian, 32% African-American, 12% Hispanic, 6% Asian, and 5% other (<https://www.cpcc.edu/planning/data-and-information>).

Research Question 2

Research Question 2: Is there a difference in demographics and academic characteristics of the students with a high school GPA of 2.6-2.99 who participated in and did not participate in the co-requisite study skills course? In Research Question 2, the researcher used Logistic Regression to examine the differences in the demographics and academic characteristics of the two groups (those with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course and those who did not participate in the co-requisite study skills course) in 2014-

2016. The demographic and academic dissimilarities of the treatment and control groups prior to propensity score matching are reflected in these findings:

- Co-requisite study skills students were more likely to be African American (19.37%, $n = 43$) or Hispanic (19.82%, $n = 44$) than in the control group as indicated by (16.91%, $n = 160$) and (14.06%, $n = 133$) respectively. Moreover, there were more White students in the co-requisite study skills sample (40.09%, $n = 89$) than the other ethnicities.
- Co-requisite study skills students were less likely to pursue non-transfer degrees (12.61%, $n = 28$) than in the control group (26.00%, $n = 246$). Meaning, there were more co-requisite students in transfer programs than non-transfer programs.
- Co-requisite study skills students were less represented among male students, indicating that they were less likely to enroll in co-requisite study skills courses (51.80%, $n = 115$) than enroll (57.82%, $n = 547$). Meaning, there were more female students in the co-requisite study skills classes than male students.
- Students who were full-time were less likely to enroll in a co-requisite study skills course (66.17%, $n = 626$) than enroll (85.14%, $n = 189$).
- Students classified as first time in college (FTIC) were less likely to be in the control group (52.43%, $n = 496$) than in the co-requisite study skills course (62.16%, $n = 138$).
- Co-requisite study skills students who were Pell-recipients were of a higher percentage in the co-requisite study skills group (48.65%, $n = 108$) than in the control group (41.75%, $n = 395$). Meaning, more co-requisite study skills students received Pell awards.
- The average age of the students enrolled in the co-requisite study skills course was 18 years versus 20 years in the control group. Meaning, more co-requisite study skills students were recent high school graduates.

The findings suggested that, prior to matching, there were a larger percentage of co-requisite study skills students who were white, female, enrolled in transfer programs, and Pell recipients than male minority students enrolled in technical programs.

Research Question 3

Research Question 3: After propensity score matching, is there a difference in demographics and academic characteristics of the two study groups? Using chi-square tests, t-tests and a Fisher's Exact Test, the researcher also explored if there was a difference in demographics and academic characteristics of the two study groups after the matching occurred. The dissimilarities of the demographic and academic characteristics of the treatment and control groups after propensity score matching are reflected in these findings:

- Co-requisite study skills students were more likely to be White (40.5%, $n = 89$) than any other ethnicity/race (African American: 21.8%; $n = 48$ and Hispanic: 19.82%; $n = 44$).
- Co-requisite study skills students who were enrolled full-time were more likely to be in the control group (92.3%, $n = 203$) than in the co-requisite study skills group (85.0%, $n = 187$). Meaning, fewer full-time students enrolled in the co-requisite study skills group.
- Co-requisite study skills students who were first time in college were of a higher percentage in the co-requisite study skills group (61.8%, $n = 136$) than in the control group (28.6%, $n = 63$). Meaning, there were more first time in college students in the co-requisite study skills group.
- Co-requisite study skills students were more likely to pursue non-transfer degrees (12.7%, $n = 28$) than in the control group (7.7%, $n = 17$). Meaning, there were more co-requisite students in non-transfer programs than transfer programs.

- Co-requisite study skills students were less likely to be users of Pell (48.6%, $n = 107$) than recipients of Pell awards (60.5%, $n = 133$).
- There were almost equal number and percentages of males and females in the control (Female: 50.5%, $n = 111$ and Male: 49.5% and $n = 109$) and treatment (Female: 47.7%, $n = 105$ and Male: 52.3%, $n = 115$) groups – indicating a balanced representation of each gender in both groups.
- There was a significant statistical difference in the continuous variable of age both before and after matching, indicating that age was a meaningful factor in the composition of the co-requisite study skills group.

After propensity score matching, the results revealed the following: white, male, first time in college students were more likely to enroll in co-requisite study skills courses than minority and female students. There were also other findings in the characteristics worth noting: fewer students were considered full-time, Pell recipients, and enrolled in transfer programs in the co-requisite study skills courses after the matching occurred.

Research Question 4

Research Question 4: After propensity score matching, is there a difference in college level outcomes between students with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course versus those who chose not to do so? The researcher also conducted a t-test and a chi-square test after the matching to determine if there was a difference in college level outcomes between students with a high school GPA of 2.6-2.99 who participated in the co-requisite study skills course versus those of whom it was not yet available. The chi-square test analyzed six college level outcomes: credits attempted, credits completed, credits A-C, Math credits attempted, Math credits completed, and Math credits A-C. Of the six, the researcher found

no statistically significant differences in college-level course success nor in retention from a) Fall 2016 to Spring 2017, or b) Fall 2016 to Fall 2017. Credits attempted (the total number of credits a student was enrolled in at the 10% census date) was the only outcome variable considered statistically significant at $p = .05$, indicating that co-requisite study skills students were enrolled in many more credits at the start of a term (within the 10% census date) than they actually retained and completed.

The researcher also used a t-test to examine completion outcomes (Unknown, Associate, Transfer, and Certificate) and found that there was an equal percentage of students (80.9%) in the control and treatment groups who were classified as Unknown, indicating that there were many students who departed the institution with no documented reason. It was likely that some were transient students who enrolled to complete a specific course or predetermined number of credits before they returned to their home institution. There was also a similar number of transfer students in the control (17.7%, $n = 39$) and treatment groups (15.5%, $n = 34$), reflecting the utility of the MAT 171 course as a STEM transfer option, with or without the academic support.

Limitations of the Study

The researcher found that there were limitations of the study important to note before further research on this topic may be considered. One limitation was the data were derived from one large, urban community college, so the findings may not be generalizable to other institutions. Another limitation was the narrow sample scope: students with a 2.6-2.99 high school GPA who were only enrolled in MAT 171 for a short duration of time (Fall 2016 - Spring 2017 - Fall 2017). The use of propensity score matching as the research methodology also led to different limitations: the need for a larger control group versus treatment group, the reduced sample size resulting from non-matches, and potential bias from variables not included in the data set.

Recommendations for Policy

The two recommendations for policy include examining the effectiveness of the Multiple Measures Policy (using high school GPA) for placement into curriculum level mathematics/co-requisite study skills courses and emphasizing the importance of institutional personnel working together to streamline policies and curriculum for successful implementation.

Recommendation 1. Scott-Clayton (2012) of the Community College Research Center revealed that three out of every ten students are severely mis-assigned by the traditional placement testing model. As a result, the practice of using many measures, or multiple measures, to assess college level readiness emerged as a result:

A basic principle of psychological measurement is that when a construct like college readiness is measured imperfectly, one way to improve measurement is to assess the construct in multiple ways. Therefore, one way to improve the measurement of college readiness (and therefore to reduce misplacement) is to use multiple measures—such as high school GPA, the number of years since high school graduation or equivalent, the number of courses taken in the subject (e.g., English or math), and the highest level taken in the subject (e.g., Algebra I or Algebra II)—to inform placement decisions. (Bailey et al., 2016, p. 20)

The NCCCS Multiple Measures Policy, which purported the use of a high school GPA as a better predictor of college readiness, emerged in response to this notion that no singular assessment alone should determine college level placement, but rather multiple measures should be used to determine if entering students could begin college level work sooner.

Although the Multiple Measures Policy was developed, in part, to mitigate the under placement of students as a result of the placement tests, Bailey et al. (2016) encouraged

“community colleges to investigate the effects of the multiple measures policy on desired student outcomes over time. They suggest that institutions continue to monitor the effects of the placement policy and use new information to adapt, change, or expand the implementation of multiple measures policies and practices” (p. 23). Because the co-requisite remediation model in North Carolina emerged as a way to support students placed in high risk mathematics courses as a result of the Multiple Measures policy, the researcher recommends that the effectiveness of the high school GPA range of 2.6-2.99 as a placement tool is examined to ensure that this measure accurately predicts college readiness in such high risk courses.

Recommendation 2. The researcher also suggests that institutional policies and course structures are explored by key stakeholders to eliminate unnecessary barriers that would hinder the implementation of the co-requisite model. Bailey et al. (2016) espouse the importance of this administrative and faculty buy-in, collaboration, and engagement to making this model work:

Obtain faculty and leadership support for rethinking course structures and policies to efficiently support students in mastering developmental education skills and earning college credits. Support from faculty and leadership is vital to developing and implementing an effective accelerated course model, especially if the large majority of students are to be affected by the changes. Particularly for mainstreaming models, colleges must establish structures and processes for instructors to communicate with one another and ensure that students are mutually supported as they complete college-level coursework. (p. 39-40)

At the macro-level, state agencies, accreditation bodies, and other community agents must examine the interrelated policies and procedures that may prove a hindrance to course progression, completion and transfer:

College level leaders, state policymakers, regional accreditors, and discipline-specific associations should discuss adjustments to any necessary policies and procedures that would inhibit students in receiving appropriate credit for redesigned courses. Transfer and articulation policies may not currently support the acceleration models... and colleges may need to work proactively to ensure that new course models are recognized and properly credited when students transfer (Bailey et al., 2016, p. 53).

Recommendations for Practice

The two recommendations for practice include developing a comprehensive program evaluation of the co-requisite model and conducting ongoing professional development for administrators, faculty, and staff.

Recommendation 1. The researcher recommended that a comprehensive, systematic program evaluation plan is developed to measure not only the effectiveness of the intervention, but also the affordability. As developmental education costs the states and students \$1.3 billion annually, administrators at CUNY recognized that the historical remediation model was simply too exorbitant, and the sustainability of such a model, as well as its effectiveness, had to be fixed:

Requiring all students to pass remedial classes before they can earn the credits needed for their degrees imposes extra costs on students, colleges, and taxpayers—funds that could be spent on other college courses and programs. That cost, as well as our overall educational goals, should be taken into account when setting higher-education policies. College communities, and our society, must decide whether the investment is worth the results.

(Logue et al., 2017, p. 8)

In their article, Belfield et al. (2016) stated that the co-requisite model had not yet undergone a thorough, rigorous evaluation, so they urged colleges to evaluate both the efficiency and cost-effectiveness of their co-requisite redesigns as to not perpetuate an already existing problem:

Reforms will not be successful if they cost too much to implement or indeed if they significantly reduce revenue. Colleges therefore need to evaluate both the effectiveness and the efficiency of their remedial redesigns... If the co-requisite model is successful, more students will be retained and graduate. This is the goal of the strategy, but because students will be taking more courses, colleges will have to provide more courses, driving up their costs. Depending on the tuition and reimbursement model, these costs may be offset by additional revenue. (Belfield et al., 2016, pp. 1-2)

As North Carolina is one of many states exploring a state-wide adoption of the co-requisite model, creating a program evaluation plan before widespread implementation will encourage more ongoing, proactive, and formative modifications to the model rather than waiting for a summative assessment after the co-requisite model has been executed.

Moreover, standardizing the co-requisite model across the state ensures quality control so that the evaluation of the program's effectiveness considers the same programmatic elements, and thereby is more reliable in its assessment.

Recommendation 2. Finally, administrators, faculty, and staff have critical roles to play to ensure that co-requisite students have a smooth transition to college level coursework. As such, the researcher recommends ongoing, flexible professional development training for administrators, full and part-time faculty, and staff that will allow for engagement and coordination of instruction and support services. Incorporating various flexible training options to meet the needs of all key stakeholders at the institutions ensures that student success remains at

the core of the intervention, and that the faculty implementing this academic support have the tools necessary to meet the needs of all students.

And while the other roles are important to the model's success, faculty are integral to making the co-requisite plan work, and thereby require the most instructional support.

Professional development for faculty should address the following:

- a) How to maintain rigorous college level content and skill development while meeting needs of students who are not college ready in all areas.
- b) Ways to best use the institution's resources and the expertise of various instructors to compress, mainstream, or modularize content.
- c) Models for integrating accelerated course models in mathematics, reading and English, or contextualizing courses to students' academic and career interests.
- d) If computer-based tools and programs are being adopted, training and support for effectively using these tools to support accelerated course models should be provided.
- e) Demonstrating how to differentiate lesson plans for various skill levels.

(Bailey et al., 2016, p. 42)

Adjunct faculty also teach a large percentage of developmental students and require an intentional, coordinated effort to ensure they have the appropriate training to implement accelerated models. Adjunct faculty may require incentives to increase participation, but as discussed by Kosiewicz et al. (2016), engaging and supporting adjunct faculty in the curriculum design and implementation of the co-requisite model will increase capacity and ability to make an impact from the new approach.

Recommendations for Research

The two recommendations for research involve a more expansive examination of the effectiveness of the co-requisite remediation in not only math courses, but other curriculum classes, and taking a deeper look at what strategies work best for different student populations.

Recommendation 1. After examining the extant literature on co-requisite mathematics, there is an opportunity for further research on the impact of this academic support model on issues of retention and completion in high risk gatekeeper courses. Jaggars et al. (2015) noted that “acceleration may promote persistence and academic success because the reduced time in developmental education also reduces the opportunity for external factors, such as work or family responsibilities, to hinder students’ success.” (Bailey et al., 2016, p. 45) Yet, recent studies in Tennessee indicated that the co-requisite model did not have the anticipated impact on course success, particularly in mathematics. Belfield et al. (2016) affirmed that “further research is needed on the effectiveness of co-requisite remediation not only in enabling students to pass college-level math and English courses, but also on their success in other college-level courses” (p. 8). Since many states are adopting numerous interventions to support retention and completion, it is sometimes difficult to pinpoint which strategy really made the impact. Belfield et al (2016) mentioned that, in states like Tennessee, this is the case: “Community colleges were in the process of implementing an array of very substantial reforms that may have had a bearing on student outcomes” (p. 8). So which reform actually made the difference? Further research is needed to determine the effectiveness of this co-requisite model as an acceleration pathway for developmental students. Additionally, the Curriculum Improvement Project (CIP) that led to the redesign of Pre-Calculus courses may have led to student success for those with a high school GPA range of 2.6-2.99. Further research needs to be conducted to determine if the curriculum

changes impacted the college level outcomes in the co-requisite study courses for this particular group, and if so, to what degree.

Recommendation 2. Logue et al. (2017) confirmed that “the developmental requirements most affect student groups least likely to graduate from college overall: students of color, students from low-income families, and students at less-selective academic institutions. Although remedial classes are intended to help students prepare for college-level coursework, they often have precisely the opposite effect—trapping students in developmental coursework sequences that do not earn college credit” (p. 8). Institutions should then explore how the co-requisite study skills course addresses the needs of different student populations, paying particular attention to achievement gaps in underserved and/or underrepresented populations.

Belfield et al. (2016) reported after conducting a study of co-requisite remediation at the 13 community colleges in Tennessee:

It is not clear precisely what practices work best for different subject areas and students...

While pass rates increased substantially for college-level math and writing under the co-requisite model, many students who took co-requisite courses did not pass – nearly half in math. So, the co-requisite approach may not be effective for some students. Why this is the case and what approaches can work for these students are questions for further experimentation and research. (p. 9-10)

Moreover, Carnavale (2013) posited that by 2020, over 30% of all job openings will require some college or an Associate’s degree. Ensuring increased retention and completion rates of all students is not just an equity issue, it’s an economic one. Institutions must prepare all students, regardless of race, ethnicity, gender, religion, or sexual orientation, for the workforce

demands in their respective communities to promote social mobility and economic vitality.

Logue et al. (2017) agreed:

The benefits of a college degree are considerable and wide-ranging and go beyond enhanced lifetime earnings. Graduates may also enjoy lower rates of poverty, better health outcomes, be less likely to engage with the criminal justice system and report higher levels of personal happiness. If closing persistent gaps in degree attainment is a critical value, policies allowing new students to directly enroll in credit-bearing quantitative college classes deserve serious consideration (p. 8).

Community colleges must also consider the unique needs of online students and whether this academic support intervention is a viable option for distance education learners. Online education is rapidly growing as it is both flexible and accessible, so exploring support models for online learners is critical as success rates in math courses are challenging in a face to face modality alone. And as the co-requisite model includes older adult returning students (beyond the five years past high school graduation), additional research is needed to determine the variables that predict success for this unique population. Conducting randomized control studies to explore these different populations is another option for future studies.

Recommendations for Theory

The researcher used two theories as the underpinning of this study on co-requisite remediation: The Theory of Student Departure by Tinto and The Theory of Andragogy by Knowles. The first explained the importance of creating an institutional environment that compels students to remain at a college or university; the second framed the critical elements in an instructional setting that engages adult students and encourages them to participate in their learning environment. The findings from this study as well as the Tennessee study indicated that

retention and completion within the co-requisite model, particularly in mathematics, remain problematic as a large percentage of students are still not successful in curriculum mathematics courses – in spite of this additional academic support. One possible reason is the need to use design thinking as a strategic approach to this academic support paradigm. Further studies are needed to determine if the co-requisite model has been intentionally designed with adult learning and retention theories in mind, or has the co-requisite model been more of a curriculum redesign without a theoretical framework to guide the work.

Although Knowles laid the foundation for adult learning theory in the field of education, Knowles (2017) commented on the value of another recent text, *Enhancing Adult Motivation to Learn*, as the first book in education that specifically addresses how to inspire adults in a learning environment. In the text, Wlodkowski and Ginsberg (2017) suggested that curriculum designers explore the motivational framework for culturally responsive teaching when developing instructional environments for adult learners, and not just focus on the curriculum alone. Emphasizing the importance of faculty taking ownership of the learning that occurs in their classroom, they state: “Planning carefully with adult motivation in mind not only helps faculty to be more effective instructors, it also avoids a serious pitfall common to teaching: blaming learners for being unresponsive to instruction” (p. 99). The co-requisite model, designed to support at risk students in curriculum level classes, could be strengthened through the application of the Motivational Framework for Culturally Responsive Teaching, and warrants another assessment through this culturally responsive lens.

Building upon Wilson’s Model of an Andragogical Approach to Adult Student Departure, the researcher identified the following four motivational conditions that could enhance the theoretical model through further research and exploration:

1. *Establish inclusion.* How do we create or affirm a learning atmosphere in which we feel respected by and connected to one another?
2. *Developing attitude.* How do we create or affirm a favorable disposition toward learning through personal relevance and learner volition?
3. *Enhancing meaning.* How do we create engaging and challenging learning experiences that include learners' perspectives and values?
4. *Engendering competence.* How do we create or affirm an understanding that learners have effectively learned something they value and perceive as authentic to their real world? (Wlodkowski and Ginsberg, 2017, p. 101)

Although the co-requisite model was implemented in certain states, administrators, faculty and staff continue to explore its effectiveness in supporting the academic success of community college students. Including culturally responsive teaching elements in the model specifically targets the needs of the adult learner and ensures that all students feel motivated to learn in high risk courses like mathematics.

Conclusion

The long-standing value of co-requisite remediation as it relates to increased success rates in high risk mathematics courses remains to be seen. Certainly, the Accelerated Learning Program or ALP model that allows developmental English students to co-enroll in a gatekeeper English curriculum course has seen positive results (Hern, 2012). Yet, this study revealed that the historical challenges of retention and completion in curriculum mathematics courses are still evident, despite the implementation of this academic support, and are not easy to overcome. Further research is necessary on a larger sample of students to gauge if co-requisite mathematics

remediation can really move the needle on student success, and a robust evaluation of the current model is warranted to determine where the changes in the existing model must occur.

Taking any action to close the achievement gaps in underserved/underrepresented student populations, however, is a move in the right direction. Administrators at CUNY conducted a study on co-requisite remediation, and although it was their first analysis of the impact of this academic support model, they found the initial results related to course success and student engagement to be promising. They concluded:

Colleges and policymakers should consider whether students need to pass remedial classes in order to progress to credit-bearing courses. While there are several possible strategies to help students who cannot demonstrate college readiness at the outset of their studies, mainstreaming is an efficient approach with the potential to transform the college experience (Logue et al., 2017, p. 8).

Mathematics has been a barrier to retention and completion for the majority of adult learners for far too long. Although Bailey et al. (2015) argued in *Redesigning America's Community Colleges* that no singular solution made enough impact to drastically increase the percentage of graduates in our community college system, a comprehensive array of services, including co-requisite remediation, could definitely have a positive effect. Institutions must continually identify and modify those comprehensive array of services, including the co-requisite model, to ensure that they are indeed both effective and efficient while exploring the best possible solutions for community college students.

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APPENDICES




Appendix A: NCCCS Multiple Measures Policy

NCCCS Policy Using High School Transcript GPA and/or Standardized Test Scores for Placement (Multiple Measures for Placement)

Revised August 2016

The Multiple Measures policy establishes a hierarchy of measures that colleges will use to determine second semester seniors and recent high school graduates' readiness for college-level courses. The first measure is an unweighted high school GPA of 2.6, the second measure is ACT or SAT scores, and the third is placement testing. The policy stipulates that students who graduated from high school more than five years ago or who do not meet the GPA or ACT/SAT threshold must take a placement test if they are matriculating into programs that have developmental pre- reqs. Additional stipulations for this policy are found in the attached document. Colleges may implement Multiple Measures for Placement beginning Fall Semester 2013, with a required implementation date of Fall Semester 2016 for all colleges. The North Carolina Community College System will review student placement and success rates within two years of implementation of this policy and will report to the State Board of Community Colleges.

The proposed Multiple Measures for Placement Policy establishes a hierarchy of measures that colleges will use to determine students' readiness for college-level courses:

- (1) A recent high school graduate who meets the specified GPA and 4th math benchmark will be exempt from diagnostic placement testing and will be considered "college-ready" for gateway math and English courses.

- (2) If a recent high school graduate does not meet the GPA and 4th math benchmark, the college will use specified ACT or SAT subject area test scores to determine placement.

- (3) If a recent high school graduate does not meet the GPA and 4th math threshold or have college-ready ACT or SAT scores, the college will administer the diagnostic placement test to determine placement.

- (4) If an applicant does not have a recent high school transcript or ACT or SAT scores, the college will administer the diagnostic placement test to determine placement.

Multiple Measures for Placement Policy

Unweighted GPA = or >2.6 Fourth High School Math Course*	Student is college ready for any gateway math course and any course that has a DMA prerequisite. Colleges may require students to take a supplemental math lab as a co-requisite, based on college policies.
Unweighted GPA = or > 2.6 And Fourth High School Math Course*	Student is college ready for any English course up to and including English 111 and any course that has a DRE prerequisite. Colleges may
	require students to take a supplemental English composition lab as a co- requisite, based on college policies.
Unweighted GPA <2.6	College will evaluate subject-area ACT or SAT scores to determine if student is college ready in math and English using the following scores (based on national and state validation studies): English: ACT Reading 22 OR ACT English 18 SAT Writing 500 OR SAT Critical Reading 500 (If taken prior to March 2016) SAT Evidence Based Reading 480 (Beginning March 2016) Math: ACT Math 22 SAT Math 500 (If taken prior to March 2016) SAT Math 530(Beginning March 2016)
Unweighted GPA <2.6 and subject-area score(s) below college ready	Student will take subject-area State Board-approved assessment(s) to determine placement.
Students without a recent transcript GPA or without ACT or SAT scores	Student will take subject-area State Board-approved assessment(s) to determine placement

Approved by the State Board of Community Colleges on March 21, 2014 Revised August 2016

1. This policy is effective upon approval by the State Board of Community Colleges for students enrolling in Fall semester 2013. All colleges must implement the placement policy by Fall semester 2016.
2. This policy applies to an individual who has an official transcript grade point average (GPA) from a high school that is legally authorized to operate in North Carolina and who graduated from that high school within five years of college enrollment.
3. For students who apply for admission before they graduate from high school, colleges will consider a student's cumulative GPA/4th math at the end of 1st semester of 12th grade or ACT/SAT test scores in determining placement.
4. Colleges will establish local policies regarding using GPA/4th math for placement for students with transcripts from private and out of state high schools.
5. Colleges must use State Board- approved cut scores to place students into the appropriate developmental math (DMA) module or reading/English (DRE) course.
6. Colleges will establish local policies to allow students who are assessed near

college ready on the diagnostic assessment to co- enroll in a college course and the appropriate developmental education module/course that is a prerequisite for the college- level course.

7. The North Carolina Community College System will review student placement and success rates within two years of implementation of this policy and will report to the State Board of Community Colleges.
8. This policy does not apply to Career and College Promise (CCP).

*Approved by the State Board of Community
Colleges on March 21, 2014 Revised August 2016*

Appendix B: MAT 001 Co-Requisite Study Skill Courses

MAT 001. Math Skills Support. 1.0 Credit. Class-0.0. Clinical-0.0. Lab-2.0. Work-0.0

This course provides opportunities for students to build a stronger foundation for success in their corequisite math course by obtaining skills through a variety of instructional strategies. Emphasis is placed on foundational skills as well as concepts, skills, vocabulary and definitions necessary to master student learning outcomes of the co-requisite math course. Upon completion, students should be able to apply mathematical concepts and critical thinking skills to solve problems relevant to the student's co-requisite math course.

MAT 001M. Math Skills Support - Measmnt & Literacy. 1.0 Credit. Class-0.0. Clinical-0.0. Lab-2.0. Work-0.0

This course provides opportunities for students to build a stronger foundation for success in their corequisite math course by obtaining skills through a variety of instructional strategies. Emphasis is placed on foundational skills as well as concepts, skills, vocabulary and definitions necessary to master student learning outcomes of the co-requisite math course. Upon completion, students should be able to apply mathematical concepts and critical thinking skills to solve problems relevant to the student's co-requisite math course.

MAT 001P. Math Skills Support - Precalculus Algebra. 1.0 Credit. Class-0.0. Clinical-0.0. Lab-2.0. Work-0.0

This course provides opportunities for students to build a stronger foundation for success in their corequisite math course by obtaining skills through a variety of instructional strategies. Emphasis is placed on foundational skills as well as concepts, skills, vocabulary and definitions necessary to master student learning outcomes of the co-requisite math course. Upon completion, students should be able to apply mathematical concepts and critical thinking skills to solve problems relevant to the student's co-requisite math course.

MAT 001Q. Math Skills Support Quantitative Lit. 1.0 Credit. Class-0.0. Clinical-0.0. Lab-2.0. Work-0.0

This course provides opportunities for students to build a stronger foundation for success in their corequisite math course by obtaining skills through a variety of instructional strategies. Emphasis is placed on foundational skills as well as concepts, skills, vocabulary and definitions necessary to master student learning outcomes of the co-requisite math course. Upon completion, students should be able to apply mathematical concepts and critical thinking skills to solve problems relevant to the student's co-requisite math course.

MAT 001S. Math Skills Support Statistical Methd I. 1.0 Credit. Class-0.0. Clinical-0.0. Lab-2.0. Work-0.0

This course provides opportunities for students to build a stronger foundation for success in their corequisite math course by obtaining skills through a variety of instructional strategies. Emphasis is placed on foundational skills as well as concepts, skills, vocabulary and definitions necessary to master student learning outcomes of the co-requisite math course. Upon completion, students should be able to apply mathematical concepts and critical thinking skills to solve problems relevant to the student's co-requisite math course.

MAT 001T. Math Skills Support Algebra/Trig I. 1.0 Credit. Class-0.0. Clinical-0.0. Lab-2.0. Work-0.0

This course provides opportunities for students to build a stronger foundation for success in their corequisite math course by obtaining skills through a variety of instructional strategies. Emphasis is placed on foundational skills as well as concepts, skills, vocabulary and definitions necessary to master student learning outcomes of the co-requisite math course. Upon completion, students should be able to apply mathematical concepts and critical thinking skills to solve problems relevant to the student's co-requisite math course.

Appendix C: IRB Approval from Central Piedmont Community College

From: Terri Manning [<mailto:Terri.Manning@cpcc.edu>]
Sent: Wednesday, December 7, 2016 9:58 AM
To: Yolanda S Wilson <YWilson@yorktech.edu>
Cc: Bobbie Frye <Bobbie.Frye@cpcc.edu>
Subject: RE: Research Proposal Form

So you are basically just wanting data from our system to analyze. I know you have talked with Bobbie Frye but I would suggest that you talk with her again about the exact variables you want and create a template you can send to other schools that you invite. Our IR department is really good and getting this put together with us will help other colleges do it faster. You need to decide a number of things such as:

What terms of entry will you request

How long with you want to track them

What specific variable you will want from their files (e.g. demographic, test scores, high school of record)

Do you want some computed variables such as a risk indicator based on a combination of factors such as Pell + high school GPA + low suggested family income. You will need exact definitions so everyone pulls them the same.

So if you just want data, I approve your study. Bobbie's number is 704-330-6459. Let me know what letter you need and who it goes to.

Terri M. Manning, Ed.D.
Associate Vice President for Information Technology
And Research Services
CEO, Center for Applied Research
Central Piedmont Community College
P.O. Bos 35009 (Admin IV, Room 123)
Charlotte, NC 28235
Solving Real World Problems Through Quality Research and Evaluation