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Evaluating high school mathematics performance measures and student attributes for predicting remedial mathematics success and student retention in college

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EVALUATING HIGH SCHOOL MATHEMATICS PERFORMANCE MEASURES AND STUDENT ATTRIBUTES FOR PREDICTING REMEDIAL MATHEMATICS SUCCESS AND STUDENT RETENTION IN COLLEGE

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Doctor of Education
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Approved by:
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APPROVAL OF DISSERTATION

I hereby affirm that the following project meets the high academic standards for original scholarship and creative work established by my discipline, college, and the Graduate College of Marshall University. With my signature, I approve the manuscript for publication.

Project Title: Evaluating High School Mathematics Performance Measures and Student Attributes for Predicting Remedial Mathematics Success and Student Retention in College

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11/15/2016 — Date

DEDICATION

To those conditionally admitted students who successfully completed developmental math and went on to earn a bachelor's degree, I hope you found success in your field of choice.

To those conditionally admitted students who did not succeed in developmental math, I wonder where you are and where you would be if math had not been such a struggle for you. I hope you found other paths to success.

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To Bella, Mio, and Luna, thank you for always being happy to see me when I come home. Wagging tails and puppy kisses can restore a tired soul.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

The purpose of this study was to evaluate multiple high school student attributes and performance measures that could be considered for use in predicting success in developmental mathematics courses and college-level math courses at Marshall University in Huntington, West Virginia. This study also evaluated the predictive ability of the same high school student attributes and performance measures in determining first-year fall-to-fall retention rates for successful math students.

The study population consisted of first-time freshmen who entered the case study institution in the fall semesters of 2010 through 2014 and graduated from West Virginia public high schools. The population was stratified by the developmental or college-level course in which the student enrolled. A stratified sample was selected from the population based on math course. Data for each student in the sample population was collected from high school transcripts and matched with additional student data in the university student database. Multiple statistical analyses were employed to determine the significance of each of the twelve independent variables in regard to student performance outcomes in developmental and college-level math courses and fall-to-fall retention outcomes.

High school overall GPA and high school math GPA significantly influenced more course outcomes than any other variables. Socioeconomic variables were significant in the course outcomes for MTH 098 and MTH 121. Variables were inconsistent in influencing retention outcomes.

CHAPTER ONE: INTRODUCTION

Maruyama (2012) ascertained that “college readiness represents an accumulation of knowledge and experiences that prepare students for college…using measures available during high school that can act as proxies for how students perform in college courses and later in careers” (p. 253). Conley (2007a) proposed that college readiness is “the level of preparation a student needs in order to enroll and succeed—without remediation—in a credit-bearing general education course at a postsecondary institution that offers a baccalaureate degree or transfer to a baccalaureate program” (p. 5). Yet, the specific skills that determine whether or not a student is college-ready are not objectively defined, and what is determined as college-ready at one postsecondary institution may not qualify at another institution (Attewell, Lavin, Domina, & Levey, 2006). To adequately determine college readiness, we must be able to determine a measure that reflects “competence, proficiency, and understanding of requisite content” (Maruyama, 2012, p. 253).

The alignment of secondary and postsecondary education standards is ranked number seven on the list of top ten higher education policy issues for 2015 according to the American Association of State Colleges and Universities (AASCU, 2015). The high number of students needing remediation signal that there is a discrepancy in the secondary curricula and the postsecondary expectations (Howell, 2011). Supporting this indication of misalignment between what is expected in college and what is being attained in high school, is the fact that there are many students who successfully complete college preparatory tracks in high school who must still enroll in remedial courses upon entry to four-year colleges (Attewell et al., 2006; Tierney & Garcia, 2008).

Atkinson and Geiser (2009) contend that we have limited ability to predict college performance by using measurements available at the time a student is admitted to college. Most colleges and universities use a high school grade point average in combination with a college entrance exam score to determine eligibility for admission. Subject scores on these entrance exams are often used for placement in mathematics, reading, or English courses, yet there is no generally agreed upon cut-score below which a student is determined to be in need of remediation (Attewell et al., 2006).

The ultimate measure of college readiness is determined by the performance in the college-level courses (Conley, 2007a). Conley further noted that students who fail entry-level courses or place initially in remedial courses are less apt to graduate (Conley, 2007a). Higher education administrators are responsible for finding a way to effectively and efficiently place and remediate students. It is a disservice to the student and the college or university to admit students needing remediation and not provide the proper support systems and effective pedagogies for students to succeed in and beyond remediation.

Theoretical Framework

This study was guided in part by the framework established by Maruyama's (2012) investigation of different models utilized for assessing college readiness. Maruyama's work contends that:

> Assessments of college readiness should (a) use benchmarks with meaning and consequences for students, (b) employ multiple measures to provide readiness information more precise than from a threshold score derived from any single assessment, and (c) present readiness in terms of probabilities or likelihoods rather than as ready or not. (p. 252)

Maruyama's (2012) study resulted in a set of seven principles that should be employed when determining if a student is college ready. These principles are:

Principle 1: Benchmarks should be logical and consequential.

Principle 2: Benchmarks should recognize and acknowledge limitations.

Principle 3: In defining readiness, a range of different approaches, assessments, and formats should be employed, ideally using multiple measures.

Principle 4: Information about probabilities or likelihood of success is valuable and informative for students at every score.

Principle 5: In selecting measures, as much as possible use information already being collected, including course grades and course taking patterns, to minimize burden on schools and students.

Principle 6: Readiness information ideally is tied to behaviors that students can act upon.

Principle 7: Defining college readiness is of critical importance and impact and should employ a process that engages stakeholders. (p. 254, 258-259)

This case study will investigate Maruyama's (2012) Principles 3, 4, and 5. By following these principles established in Maruyama's study and utilizing a greater number of high school performance measures, postsecondary institutions should be better prepared to predict those students who will succeed in developmental mathematics and those who will need additional academic support to succeed. This allows postsecondary educators the opportunity to implement recommendations or requirements for additional academic support programs and services (Laskey & Hetzel, 2011).

Statement of the Problem

The education standards alignment between secondary and postsecondary schools, oftentimes referred to as college readiness, has been at issue for many years. Strong American Schools (2008) reported that 29% of students attending a four-year public college have enrolled in at least one remedial course. In 2014, the AASCU ranked college readiness as number six in the top ten issues for higher education noting that one in five students in public four-year colleges enrolled in one or more remedial courses in English, reading, and/or mathematics. The greatest gap in readiness is in mathematics (National Center for Education Statistics, 2003).

Attewell et al. (2006) state that there is no clear or consistent definition of what constitutes a student as college-ready. Bailey (2009) further notes that there is no one generally accepted model for predicting college readiness. “This uncertainty is reflected in the bewildering plethora of assessments and cutoff points used around the country and perhaps even more important, there is no break or discontinuity in assessment test scores that clearly differentiates developmental from college-level students” (Bailey, 2009, p. 17). Nevertheless, the ability to place students in the appropriate level of mathematics courses is critical for institutions of higher education in promoting the success of students whom they have admitted (Boylan, 2009).

Maruyama (2012) investigated several different models of assessing college readiness and suggests a multidimensional framework for determining the probability of college readiness. To date, there has been little research to validate Maruyama’s findings. This study will utilize a case study approach to apply three of the principles defined in Maruyama’s framework to the assessment of readiness for college mathematics in a medium-size public regional university.

Research Questions

The specific research questions that will be addressed in this study are the following:

1. Which high school measures and student attributes best predict performance in remedial math for graduates of West Virginia public high schools enrolling at Marshall University?
2. Which high school performance measures and student attributes best predict college readiness for math for graduates of West Virginia public high schools enrolling at Marshall University?
3. For students who succeed in remedial math, which high school performance measures and student attributes best predict success in college-level math for graduates of West Virginia public high schools enrolling at Marshall University?
4. Using college readiness in math as a filter, which high school performance measures and student attributes best predict first-year to second-year retention for graduates of West Virginia public high schools enrolling at Marshall University?

Operational Definitions

For the purposes of this study, the following operational definitions are used:

Sex – The sex the student self-reported on his or her college admissions application, i.e. male or female. Data were obtained from the Marshall University student database.

Ethnicity – The ethnicity the student self-reported on his or her college admissions application, i.e. Hispanic/Latino; American Indian or Alaskan Native; Asian; Black or African American; Native Hawaiian or Other Pacific Islander; or White. Data were obtained from the Marshall University student database.

County – The county in which the high school the student attended is located. Data were obtained from the Marshall University student database.

Highest ACT Mathematics Score – The highest ACT subject test in mathematics score a student achieved and submitted to the case study institution. Data were obtained from the Marshall University student database.

Highest SAT Mathematics Score – The highest SAT mathematics score a student achieved and submitted to the case study institution. Data were obtained from the Marshall University student database.

High School Attendance in Senior Year – The number of days a student attended high school in his or her senior year as reported on the high school transcript provided to the case study institution. An attendance percentage rate will be calculated based on the days attended and days of possible attendance as recorded on the transcript. Data were obtained from the student's high school transcript.

High School Mathematics Grades – The respective grades a student earned in each of the mathematics courses taken by the student while in high school as reported on the high school transcript provided to the case study institution. Data were obtained from the student's high school transcript.

High School Mathematics Grade Point Average (GPA) – A calculated grade point average based on a 4.0 scale of all grades for math courses taken by the student while in high school as reported on the high school transcript provided to the case study institution.

High School Grade Point Average (GPA) – The final high school grade point average as reported by the high school on the final high school transcript provided to the case study institution. Data were obtained from the Marshall University student database.

Postsecondary Developmental Mathematics Course – The remedial math course in which a student enrolls at the case study institution. During the time of this study, the developmental courses offered included MTH 098 (Basic Skills in Mathematics I) and MTH 099 (Basic Skills in Mathematics II). Data were obtained from the Marshall University student database.

Postsecondary Developmental Mathematics Grade – The grade a student earns in the remedial math course in which the student enrolls at the case study institution. Students enrolled in MTH 098 (Basic Skills in Mathematics I) and MTH 099 (Basic Skills in Mathematics II) earn grades of CR (credit) or NC (no credit). Students who withdraw receive a grade of W. Data were obtained from the Marshall University student database.

Postsecondary 100-Level Mathematics Course – The 100-level math course in which a student enrolls at the case study institution. During the time of this study, the 100-level math courses included MTH 121 (Concepts and Applications), MTH 127 (College Algebra Expanded), and MTH 130 (College Algebra). Appropriate course was determined by standardized test cut score and selected academic major. Data were obtained from the Marshall University student database.

Postsecondary 100-Level Mathematics Course Grade – The grade a student earns in the 100-level math course in which a student enrolls at the case study institution. Students enrolled in MTH 121 (Concepts and Applications), MTH 127 (College Algebra Expanded), and MTH 130 (College Algebra) earn standard letter grades of A, B, C, D, or F. Students who withdraw receive a grade of W. Data were obtained from the Marshall University student database.

Fall-to-Fall Retention – The continued enrollment of a student in the fall semester following his or her enrollment in the previous fall semester at the case study institution as a first-time freshman. Data were obtained from the Marshall University student database.

Estimated Family Contribution (EFC) – The Estimated Family Contribution is an amount calculated by the U.S. Department of Education that estimates the financial support a family should be able to provide toward the annual costs of higher education. Data were obtained from the Marshall University student database.

Pell Grant Eligibility – The determination of a student's eligibility for Federal Pell Grant assistance as determined by the family's financial information submitted on the Free Application for Federal Student Aid (FAFSA) for the first year of enrollment as a first-time freshman at the case study institution. Data were obtained from the Marshall University student database.

Unmet Financial Need – A calculation of the student's cost of education minus the amount calculated by the federal government via the FAFSA submission as the amount a family can contribute toward the cost of education (Estimated Family Contribution or EFC) minus any aid received. A positive unmet need implies the student's educational costs have not been fully met while a negative unmet need implies the student's educational costs have been met. Data were obtained from the Marshall University student database.

Mother's Level of Education – The level of the mother's education as self-reported by the student on the Free Application for Federal Student Aid (FAFSA), i.e. Middle School/Junior High; High School; College or Beyond; Other/Unknown; or blank. Data were obtained from the Marshall University student database.

Father's Level of Education – The level of the father's education as self-reported by the student on the Free Application for Federal Student Aid (FAFSA), i.e. Middle School/Junior High; High School; College or Beyond; Other/Unknown; or blank. Data were obtained from the Marshall University student database.

Significance of the Study

First-time freshman students who are successful in remedial mathematics have proven to be successful in college-level mathematics and in student persistence (Bettinger & Long, 2008; Gallard, Albritton, & Morgan, 2010). In order to seek out better predictors of developmental and college-level success, this case study will evaluate the high school performance measures relative to success in developmental and college-level math courses taken in a student's first year of college by following Maruyama's (2012) recommended framework for determining probabilities for college readiness. The results of this study will contribute to the available literature on the predictive value of multiple high school performance measures on the success of remedial mathematics students in developmental and college-level courses and will contribute to the knowledge base that will assist higher education administrators in placing and providing support for remedial students.

Laskey and Hetzel (2011) stated that underprepared students who lack basic skills are at-risk for failing to complete a bachelor's degree without additional academic support. Based upon this predictive model, administrators, faculty, and advisors at postsecondary institutions will be able to enhance and develop additional academic support programs and recommend or require student participation in those programs in order to provide the best opportunities for success.

In determining the measures that best predict success, administrators at the postsecondary and secondary levels can encourage student success at the secondary level by (1) assisting postsecondary educators in determining students best suited for recommended and/or required academic support programs; (2) communicating to secondary students the significance of their performance in the most predictive areas for future college success, and (3) eliminating or limiting the perceived disconnect between secondary and postsecondary expectations by informing postsecondary collaborations with secondary institutions, students, and their families as they prepare for college enrollment. As a result, remedial students should be better equipped to succeed in and beyond remediation and higher education administrators can reap the benefits of increased retention.

Delimitations of the Study

This study will be limited to an analysis of high school performance measures and the resulting success or failure in developmental mathematics and college-level mathematics for a randomized sample of first-time freshman students enrolled at Marshall University in Fall 2010, Fall 2011, Fall 2012, Fall 2013, and Fall 2014 who graduated from West Virginia public high schools. The sample population is limited to a random sample determined by first math course taken at the case study institution. Students randomly selected for the study will have placement scores that do not qualify for college-level mathematics and who enrolled in developmental mathematics in their first semester or met the placement score requirement and enrolled in college-level math courses. The entire population of students meeting the desired criteria will not be evaluated.

Organization of the Study

This research study adheres to the following organizational structure. Chapter One provides an introduction, a statement of the problem, specific research questions, the theoretical framework for the study, operational definitions relative to the study, and the significance and delimitations of the study. Chapter Two is a review of the literature relating to college preparedness, college-level remediation, academic support for at-risk students, and collaborative efforts between secondary and postsecondary institutions. Chapter Three is a description of the data collection and research methods.

Chapter Four presents the results of the study. Chapter Five provides an analysis of the findings, offers a discussion of the implications of the findings, and offers recommendations for future research.

CHAPTER 2: REVIEW OF THE LITERATURE

College Readiness and the Need for Remediation

Attewell et al. (2006) contend that different colleges and universities have different expectations for college readiness and there is no clear delineation of what defines college-level work. There are a multitude of tests and cut-scores and a range of cut-off points whereby students are determined to be college ready, yet research shows no clear break in the scores that determine who is ready for college and who is not ready (Bailey, 2009). Boylan (2009) held that although using a single cut score for placement was efficient, it was likely not effective. The Charles A. Danner Center, Complete College America, Inc., the Education Commission for the States and Jobs for the Future (2012) concurred. Their report entitled *Core Principles for Transforming Remedial Education: A Joint Statement* proposed that "…the evidence of the predictive validity of these tests is not as strong as many might assume, and research fails to find evidence that the resulting placements into remediation improve student outcomes" (p. 3). Further, college administrators have limited ability to predict whether or not a student will succeed in college (Atkinson & Geiser, 2009).

Another failure in remediation is the lack of consistency among states and even schools within the same state. The Education Commission of the States (2014a) found that schools do not uniformly agree on what is considered to be college ready and calls for states to determine how high school standards for college and workforce readiness should be acknowledged at the college level.

When students enter college, their ability to transition and adjust to the social and academic expectations goes beyond their content knowledge and desire to succeed; it is a compilation of school, teachers, peers, and family influences (Howell, 2011). Kern (1998) noted that attitudes about achievement are essential to academic success. Astin (1999) further suggested that the "…amount of learning and personal development associated with any educational program is directly proportional to the quality and quantity of student involvement in that program" (p. 519). Laskey and Hetzel (2011) later added that motivation was also a contributing factor. Conley (2007a) with the Educational Policy Improvement Center (EPIC) agreed that college-readiness is complicated; it is more than grade point averages and standardized test scores. According to studies conducted by EPIC, a holistic view of college readiness considers the interconnectedness of several factors including contextual skills and awareness, key cognitive strategies, academic knowledge and skills, and academic behaviors. Relating this theory specifically to math readiness, Conley stated:

> Most important for success in college math is a thorough understanding of the basic concepts, principles, and techniques of algebra…College ready students possess more than a formulaic understanding of mathematics. They have the ability to apply conceptual understandings in order to extract a problem from a context, use mathematics to solve the problem, and then interpret the solution back to the context. (Conley, 2007a, p. 15)

McCormick and Lucas (2011) simply stated that a student is college ready in mathematics if he can succeed in college-level math without remediation. The National Center for Education Statistics (NCES, 2003) defined remedial education as courses "…for college-level students lacking those skills necessary to perform college-level work at the level required by the institution" (p. 1). A decade later, NCES (2013) updated the definition to state that remedial courses are "…courses for students lacking skills necessary to perform college level work at the degree of rigor required by the institution" (p. 1). Neither report defines the specific skills that are necessary to perform at the college level.

Beyond the varied definitions of college readiness, there is the question of how students are expected to prepare themselves for college. Tinto (1988) theorized that all individuals must make adjustments to prepare for that intellectual transition to college. In addition to factors such as parental education and family income, Kuh (2007) observed that pre-college academic preparation including study habits and behavior patterns is a significant determinant of college success. Adelman (2006) also suggested that the strength of the high school curriculum is one of the strongest determining factors of success in college. Atkinson and Geiser (2009) stated that "Working hard and performing well in one's high school course work is the surest route to college" (p. 670). This leads one to question why colleges and universities do not place more emphasis on multiple high school performance factors when determining college readiness and placement in certain courses.

Scott-Clayton and Rodriquez (2015) surmised that placing students in developmental education signaled students that they were unlikely to complete their college education and that "…it may be efficient to both the student and the institution to realize this and adjust their investments sooner rather than later" (p. 5). They further stated that remediation does little to increase a student's likelihood to succeed in college.

The need for remediation is costly as well as a poor substitute for an adequate high school education (The Alliance for Excellent Education, 2011). The Alliance for Excellent Education (2011) indicated that the remediation costs are significant for our postsecondary institutions, the students needing remediation, and the entire nation. The postsecondary institutions need to provide the remediation, but students experience the cost of additional courses, high failure rates, and the potential for losing lifetime wages when they do not succeed in college. The report stated:

> Not only is remediation an ineffective solution to the preparation gap problem, it is also a wasteful use of public and private dollars. Helping students catch up to the expectations of postsecondary work affects the nation's overall economic strength and involves significant costs for taxpayers, postsecondary institutions, and students. (Alliance for Excellent Education, 2011, p. 4)

The Mismatch between Secondary and Postsecondary Expectations

In 2009, President Barak Obama addressed a joint session of the U.S. Congress and declared that the United States in the year 2020 will once again claim the highest proportion of college graduates in the world (Obama, 2009). According to his comments, the attainment of this goal is essential for the United States to be able to compete in a global economy and challenged each American student to complete high school and enroll in a community college, a four-year college, vocational education, or career training.

Enrolling is not enough. In order for our students in this country to meet this goal, students must be equipped to succeed. Failure to graduate the underprepared student only perpetuates the economic and social challenges facing our country today (Astin, 2000). Strong American Schools (2008) claimed that "College remediation is one of the most serious education issues facing our country and policymakers and educators must address it immediately. Our economy, our security, and our government, all depend on a steady supply of college-educated graduates" (p. 5).

The American Association of State Colleges and Universities (AASCU, 2008) recognized that the problem does not rest with the remediation of students, but the need for remediation in the first place. "Rather, the underlying causes of remediation need to be addressed so that increasing numbers of students enter postsecondary education ready for college-level work" (AASCU, 2008, p. 8). The Southern Region Education Board (SREB, 2010) stated that "Their high school diploma, college-preparatory curriculum, and high school exit examination scores did not ensure college readiness" (p. 1) and supported this statement by declaring that low graduation rates in postsecondary institutions were a result of poor preparation noting that the majority of students who enroll in remedial coursework do not persist to graduation. The SREB (2010) further challenged that "…improving college readiness must be an essential part of national and state efforts to increase college degree attainment" (p. 2).

Preparation Matters, a report by ACT's National Center for Educational Achievement (2009) stated that actual student learning is the fundamental goal of taking courses. It is not merely to receive academic credit on a transcript; however, research indicates that receiving credit in a course does not mean the student has mastered the course content. In many cases, poorly prepared students in a classroom force the teacher to remediate students not allowing time to cover new material.

No single factor is an effective predictor of success in college; however, "…the accumulation of academic skills and preparation in high school is the single best predictor of college outcomes" (Kurlaender & Howell, 2012, p. 4). Yet, Kurlaender and Howell (2012) noted that many students attend elementary and secondary school systems with insufficient levels of academic quality and rigor, particularly in the core subjects of English and mathematics. In 2008, an organization called Strong American Schools (SAS) in Washington, D.C., released a report called *Diploma to Nowhere*. SAS (2008) reported that 29% of students at four-year public colleges had enrolled in a remedial course and also reported that four in five students in remedial courses had high school grade point averages of 3.0 or better. The report further indicated that nearly 60% of students reported that their high school classes were easy and nearly half of the students wished they had taken more challenging courses. The report concludes that a high school diploma does not guarantee a student is prepared for college (SAS, 2008).

Adelman (2006) observed that there was a considerable gap between the high school curriculum and what colleges and universities expect students to have learned. The AASCU (2008) suggested that the reason high school graduates are not prepared to succeed in college is due to a "…misalignment between high school and college expectations" (p. 1) citing that our K-12 educational systems were never created to prepare all students for colleges. The organization further pointed out that some students intentionally choose easier courses and some teachers may have low expectations and fail to encourage students to take more challenging courses. Other students simply perform poorly due to lack of ability or lack of motivation (AASCU, 2008).

In 2005, Achieve, Inc., published a report called *Rising to the Challenge: Are High School Graduates Prepared for College and Work?* This report found that while "…public high schools are doing a good job of preparing many graduates, they are seriously failing a substantial minority" (Achieve, Inc., 2005, p. 2). In summary, the report stated that two in five high school graduates found their skills lacking in what was needed to be successful either in college or in the work force. The majority of students in the study reported that they would have applied themselves more had they realized the consequences and fewer than a quarter felt they were sufficiently challenged by the course work in high school. According to the report, a large majority of graduates would have worked harder if their course work had required it and they would support more rigorous standards for high school graduation (Achieve, Inc., 2005).

Using Non-Traditional Predictors in Measuring College Readiness

ACT (2004) found evidence of grade inflation of high school grade point averages from 1991 to 2003 for the same level of student achievement and argued that the standardized ACT exam measures and evaluates student achievement across schools and time. The high school grade point average has also taken criticism due to the lack of a standardized grading system across schools but studies also show that high school grades are less influenced by the student's socioeconomic status than standardized tests (Atkins and Geiser, 2009). Boylan (2011), however, contended that high school grade point averages often measure more than just the content knowledge of the course; the grades often include a "measure of effort and extra credit as an indicator of success" (p. 21).

On the other hand, Atkinson and Geiser (2009) theorized that "…grade point average (GPA) in academic subjects in high school has proven to be the best overall predictor of student performance in college" (p. 665). In addition to lower ACT composite scores and lower ACT mathematics subject test scores, Bettinger and Long (2005) determined that students enrolled in remedial mathematics courses in college self-reported lower high school math grade point averages and had taken fewer math courses in high school than students determined to be college ready. The amount of time that elapses from the final high school math course to the first college math course is another predictive factor in determining success in the college mathematics courses (Boylan, 2011).

Adelman (1998) asserted that the first step needed to "…fix the problem in the pre-college years, we have to know where to take the toolboxes…Knowing which secondary school performance indicators are the best guides to the most effective use of tools is second" (p. 11) and further noted that the nature of the high school curriculum is a starting point. Schneider, Swanson, and Riegle-Crumb (1998) cautioned that the curriculum issue started well before high school stating that "…course sequences in subjects such as mathematics and science are typically organized hierarchically by topic and ability grouping" (p. 25) noting that the intensity and duration of the courses are also part of the equation. Adelman (2006) later ascertained that high schools with a lower socioeconomic status often failed to offer math courses above the Algebra 2 level and suggested that higher math courses in the high school curriculum were key to securing a path to a bachelor's degree. Long, Iatarola, and Conger (2009) found that students who take higher level math courses in high school require less remediation, but many still require some remediation. This study concluded that students either (1) do not retain the knowledge from the course content; (2) are not motivated to prepare for tests that result in course placement; or (3) the students never learned the material but still received passing grades (Long et al., 2009).

Maruyama (2012) cautioned that neither high school graduation nor ACT or other standardized test cut scores guaranteed a student was ready for college-level work. His overarching argument contends that:

> Assessments of college readiness should (a) use benchmarks with meaning and consequences for students, (b) employ multiple measures to provide readiness information more precise than from a threshold score derived from any single assessment, and (c) present readiness in terms of probabilities or likelihoods rather than as ready or not. (p. 252)

Maruyama (2012) further asserted that there should be a range of alternate approaches to determining college readiness utilizing multiple high school performance measures including the patterns of courses taken and specific course grades to triangulate readiness and define range of probability for success.

Academic Support for At-Risk Students

While the terms “remediation” and “developmental education” are often interchanged, the term “developmental education” implies more than just remediating the content knowledge and associated skills. Developmental education implies a more comprehensive approach to not only remediating skills and knowledge, but teaching students how to become successful learners (Arendale, 2005). Gallard et al. (2010) defined developmental education as “…a comprehensive process that focuses on the intellectual, social, and education growth and development of all students. Developmental education includes, but is not limited to, tutoring, personal and career counseling, academic advising, and coursework” (p. 10).

Kuh (2007) found that nearly 90% of high school students indicate they want to go to college, but they do not participate in the educational behaviors that set them up for success in college. Nearly half indicated that they study three or less hours per week when the average college freshman studies between 13 and 14 hours. Not only are they not prepared academically, they “…have not developed the habits of mind and heart that will stand them in good stead to successfully grapple with more challenging intellectual tasks…” (Kuh, 2007, para. 5). Kuh further acknowledged that educational institutions must provide opportunities for students to improve their skills and behaviors. High school graduates are arriving at college without having established the habits and behaviors that lead to success in college and oftentimes they do not know their own skill deficits (Boylan, 2011).

First-year college students who enroll in courses to help them acknowledge and attain their skill deficits and assist in the social transition to college performed better than those who did not participate in such courses (Kuh, 2007). The Charles A. Dana Center et al. (2012) also observed that underprepared students typically benefit from non-academic supports in the area of career exploration, clarifying and setting goals, campus engagement, and balancing the demands of school, home, and work.

Attewell et al. (2006) pointed out that remediation does not mean that students will not graduate; instead, students who are remediated graduate at a rate about two-thirds that of students who do not require remediation. Bettinger and Long (2005) noted that students who do not require remediation are likely better prepared in the first place; therefore, comparing remedial students to non-remedial students alone is not satisfactory. Students are not randomly placed in remediation. Adelman (1998) proposed that "…remediation in higher education is not some monolithic plague that can be cured with a single prescription. Determined students and faculty can overcome at least mild deficiencies in preparation" (p. 11).

"Access without support is not opportunity" (Engstrom & Tinto, 2008, p. 50). Bettinger and Long (2008) surmised that the purpose of remedial education was to provide students with the skills they would need to succeed, but often produces in the student a psychological stigma that negatively affects success. One of the most difficult challenges for educators is to convince underprepared students that they can succeed given the right amount of support and motivation (Giuliano & Sullivan, 2007). Given the support needed, underprepared students can "catch up" (Moore, 2004, p. 32).

Tinto (1999) was of the opinion that students could do more than catch up. Students could surpass better prepared classmates if provided with the appropriate supports. Engstrom and Tinto (2008) found that students who participated in learning communities felt a sense of belonging even when taking non-credit-bearing developmental courses because they came to understand the importance of the course to their future educational success. Boylan (2009) offered that "…time in developmental education is well spent for many of these students…their participation enables them to develop the skills necessary for success in later college-level courses" (p. 14).

When asked about specific suggestions for math instructors to incorporate additional learning opportunities, Boylan (2011) noted that instructors should integrate the following:

> …the lecture with manipulatives, math study skills, and group work; learning math vocabulary words; using web-based support; tutoring students based on their learning style; giving frequent quizzes and practice tests; and inviting counselors into the class to discuss anxiety issues and provide a referral for personal problems. (p. 22)

Conley (2007a) added that students should also develop a range of numeric principles that could lead to higher-level math courses for a chosen major including concepts such as multi-step problems, the use of math beyond algebra, attention to detail and precision, and the ability to explain the rationale behind the strategies used in solving the problem. Great emphasis must be placed on instructional interventions and strategies and instructors must be provided with appropriate instructional resources (Moore, Slate, Edmonson, Combs, Bustamante, & Onwuegbuzie, 2010).

Conley (2007a) recognized that successful college students were able to recognize when they were having problems and understood when they needed to seek help from their professors, other students, or other university sources. In order for a greater range of students to attain degree completion, higher education institutions have the responsibility to provide and expand the supports that underprepared students need to succeed (Laskey & Hetzel, 2011). College administrators are obligated to identify those students with mild deficiencies and provide the proper support to help them recognize when they are faltering and identify sources of support that could significantly increase their success rates in terms of advancement to college-level courses. "The plain truth of the matter is that if students don't succeed in developmental education, they simply won't have the opportunity to succeed anywhere else" (Gallard et al., 2010, p. 10).

The SREB (2010) placed an onus on the higher education institutions to develop "graduation-oriented cultures that are focused strongly on student success, through attentive leadership at all levels and an array of programs, processes, and policies that work in collaboration to serve students effectively and help many of them complete bachelor's degrees" (p. 11). Some of the SREB recommendations include making graduation the first priority; providing additional instruction for students who need additional skills in reading, writing, and math; and making sure that the selection, performance, evaluation, and accountability of all campus administrators at all levels are student success focused (SREB, 2010).

Secondary and Postsecondary Collaboration

Conley (2007a) held that there is a clear distinction between high school competence and college readiness. The high school learning experience "has been reduced to a form of sleepwalking, requiring no deep mastery or understanding" (Conley, 2007b, p. 23). Adding additional courses without improving rigor is not solving the problem. Higher education leaders must develop collaborations and work with K-12 institutions, adult basic education and other training opportunities to reduce the need for remediation at the postsecondary level (Charles A. Dana Center et al., 2012).

It is essential that we minimize the gap between the student's high school experience and college expectations (Conley, 2007b). Conley (2007b) proposed several strategies for minimizing the gap. Those strategies include the alignment of the high school curriculum with postsecondary expectations by comparing course content and developing an academic focus on the last two years of high school; implementation of high quality syllabi in all high school courses similar to those used in college; the implementation of senior seminars to replicate what students should expect in college; and reintroducing the missing high school content such as vocabulary, historical themes, strategic reading, problem-solving, the scientific method, and more. Before the changes can be made in the high schools, colleges and universities must first come together to establish a consistent definition of a college-ready freshman and the skills and abilities needed to succeed (Atkinson & Geiser, 2009; Alliance for Excellent Education, 2011). A continuous dialogue is needed between K-12 and postsecondary institutions (Moore et al., 2010).

Adelman (2006) suggests that the bulk of the work lies in two areas: (1) after the student matriculates to college; and (2) in the communication between secondary and postsecondary institutions. Conley (2007a) indicated that:

> …high schools are the only place where all students have the opportunity to come into contact with information on the complexities of college preparation and application. High schools are responsible to make this information available to all students, not just those who seek it out. This means incorporating college readiness activities into the routines and requirements of the school. (p. 26)

Students and high schools must be active partners and colleges and universities must take active roles in minimizing the readiness gap by developing partnerships. “Pep talks, family visits, recruitment tours, and guidance in filling out application and financial aid forms are not enough” (Adelman, 2006, p. 108). Postsecondary institutions need to make their expectations more public (Adelman, 2006). Parents, high school teachers, and students should be able to see what college-level assignments looks like, what an examination looks like, and define additional information about what a student should expect and need to understand. These expectations should be used as “road signs to their next education destination” (Adelman, 2006, p. xix).

McCormick and Lucas (2011) listed several stakeholders in college readiness: teachers, students, parents, future employers, and government officials. The most important stakeholder is the student. Students must take control of their own futures. If a student embraces a desire to pursue higher education, then he should take some responsibility in the preparation (Adelman, 2006). College-bound students need to take more challenging classes in high school; seek external sources such as free internet classes; increase their language skills by reading more and reading challenging material; increase their mathematics skills above the Algebra 2 level because quantitative skills will be necessary in all fields of higher education; investigate college course content and syllabi by browsing college websites; and take dual enrollment courses (Adelman, 2006).

Perna and Armijo (2014) supported a P-16 or P-20 council approach to education. Such an approach ensures a “…smooth and efficient movement of students from preschool into kindergarten, through K-12 education and into undergraduate education, and from undergraduate education into and through post baccalaureate education” (Perna & Armijo, 2014, p. 17). A statewide advisory council of this nature would propose a statewide agenda for education reform and further enforce collaboration among all levels of education. Tierney (2004) supported collaboration to develop a holistic and systematic approach to student learning.

Conley (2007a) proposed that “… the intellectual climate of the school is the central element in college readiness…because the school can control this variable directly and relatively completely if its teachers and administrators choose to do so” (p. 25). K-12 institutions are faced with the need to strategically leverage funding in order to implement a comprehensive plan to reduce the need for college remediation (Alliance for Excellent Education, 2011). Adelman (1996) held that "…if schools and colleges join in a concerted effort to raise our students' basic literacy, the need for remediation in higher education should drop in direct proportion to the extent of the effort" (p. A56).

CHAPTER 3: METHODS

Introduction

The purpose of this study was to evaluate multiple high school student attributes and performance measures that could be used in predicting success in developmental and college-level mathematics courses at Marshall University in Huntington, West Virginia. This study also evaluated the predictive ability of the same high school student attributes and performance measures in determining first-year fall-to-fall retention rates.

Standards for entry in college-level mathematics at West Virginia public colleges and universities are established by the West Virginia Higher Education Policy Commission (WVHEPC) Title 133 Series 21. This policy series required students to obtain a mathematics subscore of 19 on the ACT exam or a score of 460 on the SAT mathematics exam for entry into a college-level, degree-applicable course.

For students wishing to challenge their ACT and/or SAT scores or students who do not have ACT or SAT scores, a placement exam may be administered. The Series 21 policy defines scores for three of the most common placement examinations: ACT's ASSET, ACT's COMPASS, and College Board's ACCUPLACER. Students not meeting these defined cut scores must successfully complete remedial coursework in mathematics as a prerequisite for college-level courses.

Students not meeting the required ACT or SAT mathematics subscore or not meeting the placement exam scores as defined by the WVHEPC Policy Series 21 were placed in either MTH 098 (Basic Skills in Mathematics I) or MTH 099 (Basic Skills in Mathematics II) depending upon the level of the test score. The course description for MTH 098 stated: "This course prepares students with low placement scores for the second level of the mathematics skills sequence. (PR: Math ACT < 17)." The description for MTH 099 stated: "The purpose of this course is to adequately prepare students with low placement test scores to take college level mathematics courses required in their program of study. (PR: Math ACT 17, 18 or MTH 098)" (Marshall University Undergraduate Catalog, 2010-2011, p. 394; Marshall University Undergraduate Catalog, 2011-2012, p. 401; Marshall University Undergraduate Catalog, 2012-2013, p. 456; Marshall University Undergraduate Catalog, 2013-2014, p. 300; Marshall University Undergraduate Catalog, 2014-2015, p. 302).

Mathematics requirements for students meeting the defined cut scores and eligible to enroll in college-level, degree-applicable courses vary based on academic major. For academic programs requiring algebra, the beginning math course is either MTH 127 College Algebra Expanded, a five-credit-hour course, or MTH 130 College Algebra, a three-credit-hour course. The description for MTH 127 is "A brief but careful review of the main techniques of algebra. Polynomial, rational, exponential, and logarithmic functions. Graphs, equations and inequalities, sequences. (PR: MTH 099 or Math ACT 19 or 20)" and the description for MTH 130 is "Polynomials, rational, exponential, and logarithmic functions. Graphs, equations and inequalities, sequences. (PR: Math ACT 21 or above)" (Marshall University Undergraduate Catalog, 2010-2011, p. 394; Marshall University Undergraduate Catalog, 2011-2012, p. 401; Marshall University Undergraduate Catalog, 2012-2013, p. 457; Marshall University Undergraduate Catalog, 2013-2014, p. 301; Marshall University Undergraduate Catalog, 2014-2015, p. 303).

Students studying in academic programs that do not need algebra are required to take MTH 121 Concepts and Applications, a three-credit-hour course. The description for this course is "Critical thinking course for non-science majors that develops quantitative reasoning skills.

Topics include logical thinking, problem solving, linear modeling, beginning statistics and probability, exponential and logarithmic modeling, and financial concepts. (PR: MTH 099 or Math ACT 19 or above)" (Marshall University Undergraduate Catalog, 2010-2011, p. 394; Marshall University Undergraduate Catalog, 2011-2012, p. 401; Marshall University Undergraduate Catalog, 2012-2013, p. 456; Marshall University Undergraduate Catalog, 2013-2014, p. 301; Marshall University Undergraduate Catalog, 2014-2015, p. 303).

Research Design

This study utilized a case study approach to analyzing high school performance measures as submitted to Marshall University on high school transcripts and subsequent success measures and student attributes obtained from Marshall University. Permission to utilize Marshall University data was obtained from Dr. Gayle Ormiston, Provost and Senior Vice President for Academic Affairs (see Appendix A). Approval from the Marshall University Institutional Review Board was granted in December 2015 (see Appendix B). Gerring (2004) defined a case study as "an intensive study of a single unit for the purpose of understanding a larger class of (similar) units" (p. 342). Yin (2014) further surmised that a case study method was relevant when the co-primary investigator is seeking to explain a current circumstance.

Study Population and Sample

The study population was limited to first-time freshman students entering Marshall University in Fall 2010, Fall 2011, Fall 2012, Fall 2013, and Fall 2014 who graduated from West Virginia public high schools. Specific entry terms were selected due to the consistency in the developmental math courses offered and the developmental math placement methodology utilized between the 2010-2011 and the 2014-2015 academic years. Selection of the population who attended West Virginia public high schools provided the opportunity to review commonly formatted data measures on the high school transcripts.

Marshall University's freshman class during the selected entry ranged from a low of 72% West Virginia residents in 2011 to a high of 77% in 2013 (Marshall University Data Book, 2013). Of the 9,597 first-time freshmen (FTFR) students who entered Marshall in the Fall 2010, Fall 2011, Fall 2012, Fall 2013, and Fall 2014 cohorts, 7,152 (74.5%) were West Virginia residents and 6,508 (67.8%) graduated from West Virginia public high schools. In selecting the West Virginia public high school graduates, students who graduated from out-of-state high schools, students who graduated from private high schools, students with GED scores, home schooled students, and students whose records reflected "unknown high school" were excluded. West Virginia residents who graduated from out-of-state high schools or high schools that were defunct at the time of this study were also excluded.

Once the study population was determined, the Marshall University Office of Institutional Research and Planning (MUIRP) identified the population in the Marshall University student database. The population was then stratified based on a student's entry mathematics course to ensure a sufficient number of cases for each course in the study. The aggregate numbers of students enrolled in MTH 098, MTH 099, and combined number of students enrolled in MTH 121, MTH 127, and MTH 130 were entered into an online sample size calculator to determine the number needed for a representative stratified sample reflecting a 5% margin of error with a 95% confidence level. Study population data are presented in Table 1.

Table 1. Study Population

Cohort	FTFR	WV Res	Atten. WV Pub School	Enr. MTH 098	Enr. MTH 099	Enr. MTH 121	Enr. MTH 127	Enr. MTH 130
Fall 2010	1951	1434	1287	136	177	214	99	166
Fall 2011	2003	1439	1325	162	186	237	104	179
Fall 2012	1908	1432	1298	150	212	205	131	195
Fall 2013	1873	1435	1304	117	192	216	102	220
Fall 2014	1862	1412	1294	168	100	183	119	203
Population	9597	7152	6508	733	867	1055	555	963
Stratified Sample				253	268		335	

n = 856. Stratified sample calculated with 5% margin of error and 95% confidence level.

The stratified sample of 856 students included 253 students who enrolled in developmental MTH 098, 268 students who enrolled in developmental Math 099, and 335 students who enrolled in college-level math (MTH 121, MTH 121, or MTH 130). Data in Table 2 include the number of students in the stratified sample and the number of students represented in each of the first-time freshman cohorts.

Table 2. Study Sample Population

Characteristic	*n*	%
Stratified Sample		
MTH 098	253	29.6
MTH 099	268	31.3
MTH 121, 127, or 130	335	39.1
Freshman Cohort		
Fall 2010	165	19.3
Fall 2011	176	20.6
Fall 2012	204	23.8
Fall 2013	167	19.5
Fall 2014	144	16.8

$n = 856$

Data Collection

In the first stage of the data collection, the Co-PI worked with representatives from the Marshall University Office of Admissions to review and collect data from individual high school transcripts for each student in the sample population. This manual data collection included items available on the high school transcript that are not available in the Marshall University student database including high school attendance in the student's senior year and the student's high school mathematics grades. The Co-PI calculated a high school attendance percentage and a high school mathematics GPA. The data were stored in a spreadsheet with the respective student names and Marshall University identification numbers and submitted back to the MUIRP representative.

In the second stage of the data collection, the MUIRP representative identified and matched additional selected data available in the Marshall University database for each student in the sample. The selected data included sex, ethnicity, county in which the high school resides, highest ACT Composite score, highest ACT Mathematics score, highest SAT Mathematics score, the high school grade point average, any postsecondary remedial mathematics course taken, the postsecondary remedial mathematics course grade, the 100-level mathematics course taken, the 100-level mathematics course grade, grade point averages through the course of the study, enrollment data through the course of the study, Pell Grant eligibility, estimated family contribution, unmet financial need, and mother's and father's level of education. After the high school data and the Marshall University data were matched, all identifying student information was redacted.

Data Analysis

The independent variables obtained from the high school transcripts and from the Marshall University student database were analyzed to determine whether or not there was a significant influence on either of the binary dependent variables of mathematics success or retention.

For Research Question 1 (Which high school measures and student attributes best predict performance in remedial math for graduates of West Virginia public high schools enrolling at Marshall University?), this study utilized the following data elements obtained from the high school transcript: calculated attendance percentage, high school math grades, and a calculated high school math grade point average. From the Marshall University student database, this study obtained each sample student's sex, ethnicity, the highest reported ACT Mathematics score, the highest reported SAT Math score, the high school grade point average, estimated family contribution, Pell Grant eligibility, the amount of unmet financial need, the mother's and father's level of education, the postsecondary developmental math course taken, and the postsecondary developmental math course grade.

For Research Question 2 (Which high school measures and student attributes best predict college readiness for math for graduates of West Virginia public high schools enrolling at Marshall University?), this study utilized the following data elements obtained from the high school transcript: calculated attendance percentage, high school math grades, and a calculated high school math grade point average. From the Marshall University student database, this study obtained each sample student's sex, ethnicity, the highest reported ACT Mathematics score, the highest reported SAT Math score, the high school grade point average, estimated family contribution, Pell Grant eligibility, the amount of unmet financial need, the mother's and father's level of education, the postsecondary 100-level math course taken, and the postsecondary 100-level math course grade.

For Research Question 3 (For students who succeed in remedial math, which high school measures and student attributes best predict success in college-level math for graduates of West Virginia public high schools enrolling at Marshall University?), this study utilized the following data elements obtained from the high school transcript: calculated attendance percentage, high school math grades, and a calculated high school math grade point average. From the Marshall University student database, this study obtained each sample student's sex, ethnicity, the highest reported ACT Mathematics score, the highest reported SAT Math score, the high school grade point average, estimated family contribution, Pell Grant eligibility, the amount of unmet financial need, the mother's and father's level of education, the postsecondary remedial math course taken, the postsecondary remedial math course grade, the postsecondary 100-level math course taken, and the postsecondary 100-level math course grade.

For Research Question 4 (Using college readiness as a filter, which high school measures and student attributes best predict first-year to second-year retention for graduates of West

Virginia public high schools enrolling at Marshall University?), this study will utilized the following data elements obtained from the high school transcript: calculated attendance percentage, high school math grades, and a calculated high school math grade point average. From the Marshall University student database, this study obtained each sample student's sex, ethnicity, the highest reported ACT Mathematics score, the highest reported SAT Math score, the high school grade point average, estimated family contribution, Pell Grant eligibility, the amount of unmet financial need, the mother's and father's level of education, the postsecondary remedial math course taken, the postsecondary remedial math course grade, the postsecondary 100-level math course taken, the postsecondary 100-level math course grade, the first semester college grade point average, the second semester grade point average, and fall-to-fall retention.

Summary

The research methods defined in this chapter were designed to evaluate whether or not specific high school performance measures and selected student attributes influenced the outcomes in mathematics success and retention at Marshall University for first-time freshmen who graduated from West Virginia public high schools and entered Marshall University in Fall 2010, Fall 2011, Fall 2012, Fall 2013, or Fall 2014. Reflecting on Maruyama' (2012) Principles 3, 4, and 5 for predicting college readiness, this study utilized multiple measures and evaluated those measures in their ability to predict success in mathematics and student retention by using data already available at the institution level. Findings from this study are presented in Chapter 4.

Limitations of the Study

One potential source of measurement error is the manual collection of data from high school transcripts. The data collected were not a part of Marshall University's data entry requirements for freshman admission and are not available for data extraction. Even with careful review, the manual collection of data may have resulted in errors in recording the data.

CHAPTER 4: RESULTS

Introduction

The intent of this study was to determine whether or not high school performance measures and student attributes would predict the success and retention of students in developmental math and college-level mathematics courses at the case study institution, Marshall University. The purpose of this chapter is to present the data collection process and the subsequent analysis of the data as it relates to specific research questions. The chapter is organized by a summary of the data collection and sample selection procedures, the demographics of the population and sample, and major findings. Major findings are organized by research question and data analyses.

Data Collection

Data collection occurred in two stages. In the first stage, the Co-PI worked with a representative from the Marshall University Office of Admissions to identify high school transcripts for each student in the stratified sample population. At Marshall, high school transcripts are not stored electronically; it was necessary to manually pull and review each student file stored in a physical file cabinet in the Office of Admissions storage rooms. Data items collected included grades for mathematics courses taken in high school, the number of days possible to attend in the final year of high school, and the number of days attended in the final year of high school. A high school math GPA and an attendance percentage based on the collected data were then calculated. The collected data along with the student names and identification numbers were stored in a spreadsheet which was provided to a representative from the Marshall University Office of Institutional Research and Planning (MUIRP) for further data collection.

In the second stage of data collection, the MUIRP representative matched the manually collected data with data available in the institution's student database. Data elements included high school GPA, the highest ACT Mathematics score and/or highest SAT math score, sex, ethnicity, the county of the high school attended, Pell Grant eligibility, the estimated family financial contribution, mother's and father's highest level of education, overall GPA performance during the semesters included in the study, GPA without mathematics courses taken at Marshall University, the grades in those Marshall University mathematics courses, and enrollment during the semesters of the study. The MUIRP then provided the complete data file with all student identification information redacted.

Population and Sample

The selected study population included 9,597 first-time freshmen entering Marshall University in the fall semesters of 2010, 2011, 2012, 2013, and 2014. These freshman cohorts were chosen due to the consistency of developmental math courses offered at Marshall University in this five-year time frame. The population was then narrowed to select only those students who graduated from a West Virginia public high school allowing the co-primary investigator a standard high school transcript format from which data could be collected. The population included 6,508 graduates who attended West Virginia public high schools.

The aggregate numbers of students enrolled in MTH 098, MTH 099, and combined number of students enrolled in MTH 121, MTH 127, and MTH 130 were entered into an online sample size calculator to determine the number needed for a representative stratified sample reflecting a 5% margin of error with a 95% confidence level. The sample population included 856 students randomly selected from the identified population of first-time freshman cohorts who attended and graduated from West Virginia public high schools and entered Marshall

University in Fall 2010, Fall 2011, Fall 2012, Fall 2013, or Fall 2014. The sample was stratified to identify a representative number of students who entered the first level of developmental mathematics (MTH 098 Basic Skills in Mathematics I), the second level of developmental mathematics (MTH 099 Basic Skills in Mathematics II), or college-level mathematics (MTH 121 Concepts and Applications, MTH 127 College Algebra Expanded, or MTH 130 College Algebra). The mean cohort size was 171 and the cohorts ranged in size from a low of 144 first-time freshmen in the Fall 2014 cohort to a high of 204 freshmen in the Fall 2012 cohort.

Students in the sample represented 51 of 55 West Virginia counties excluding Calhoun, Doddridge, Hampshire, and Mineral Counties. Students from Cabell County, the county in which the case study institution is located, represented 29.3% of the population. Students from nearby Kanawha and Putnam Counties represented 14% and 10%, respectively. The remaining 48 West Virginia counties accounted for 46.7% of the sample.

Females represented 62.6% of the sample while white students accounted for 85.9% of the sample (see Table 3). Students in the sample reported that 52.8% of their fathers' and 45.9% of their mothers' highest level of education was high school. Conversely, students reported that 44.8% of their mothers attended college or beyond while 33.8% of their fathers attended at that same level. The distribution of the sample's sex, ethnicity, and father's and mother's highest level of education as reported by the students on their Free Application for Federal Student Aid (FAFSA) is summarized in Table 3.

Table 3. Demographic Characteristics of the Sample

Characteristic	*n*	%
Sex		
Male	320	37.4
Female	536	62.6
Ethnicity		
White	580	85.9
Black	62	9.2
Hispanic	24	3.6
Asian/Pacific Islander	4	0.6
Non-Resident Alien	5	0.7
Father's Level of Education		
Middle School/Junior High	56	6.6
High School	450	52.8
College or Beyond	288	33.8
Other/Unknown	58	6.8
Mother's Level of Education		
Middle School/Junior High	35	4.1
High School	390	45.9
College or Beyond	381	44.8
Other/Unknown	44	5.2

n = 856

Socioeconomic factors play a role in the educational success of public school students (Adelman, 2006). Students' Pell Grant eligibility, estimated family contribution (EFC) as determined by demographic and income information reported on the Free Application for Federal Student Aid (FAFSA), and unmet need were used as indicators of student socioeconomic status. More than half (54.7%) of the students in the sample were eligible to receive a Pell Grant, a need-based federal educational grant.

Unmet need reflects the amount of educational costs not covered by financial aid or the estimated family contribution. The amount of unmet need is calculated by subtracting the estimated family contribution and the amount of financial aid awarded from the estimated cost of attendance. Unmet need less than $0 reflects one of three things: (1) the student's family contribution is greater than the cost of attendance, (2) the student has received student aid in any format that exceeds the cost of attendance, or (3) the combination of student aid in any format in addition to the family contribution exceeds the cost of attendance. Generally, an unmet need of $0 or less would imply the student can cover the cost of attendance either with aid or contributions from the family. An unmet need greater than $0 reflects a gap in the cost of attendance and what the student can afford through family or student aid sources. The distributions of estimated family contribution (*M* = 9,289.76, *SD* = 14695.81) and unmet need (*M* = 1,696.90, *SD* = 4339.18) were converted to quartiles and results are presented in Table 4.

Table 4. Financial Characteristics of the Sample

Characteristic	*n*	%
Estimated Family Contribution (EFC)		
$0	304	35.8
$1 - $3,342	121	14.2
$3,421 - $12,544	213	25.1
$12,604 - $99,999	212	24.9
Unmet Need		
-$17,016.00 - $0.00	329	38.4
$40.00 - $754.95	99	11.6
$760.00 - $3,930.00	214	25.0
$3,932.00 - $18,916.00	214	25.0

n = 856

Overall high school GPA, high school math GPA, highest ACT Mathematics score, highest SAT Mathematics score, and high school attendance rate were the academic performance factors used as independent variables in this study. The case-study institution is primarily an

ACT institution; however, SAT scores are also accepted for admission and placement. Guidance from the West Virginia Higher Education Policy Commission (WVHEPC) Policy Series 21 establishes a threshold of an ACT Mathematics score of 19 or an SAT Math score of 450 for enrollment in college-level math. The data in Table 5 show the distribution of the high school academic performance factors for the sample. The sample's overall high school GPA (*M* = 3.26, *SD* = 0.58) was higher than the high school math GPA (*M* = 2.65, *SD* = 0.81). The sample's highest ACT Mathematics scores ranged from 13 to 30 (*M* = 18.56, *SD* 3.12) and the highest SAT scores ranged from 260 – 640 (*M* = 440.1, *SD* = 74.91). The distributions of each of these performance factors was calculated in quartiles for presentation in Table 5.

Table 5. Academic Performance Characteristics of the Sample

Performance	*n*	%
Overall High School GPA		
0.77 – 1.99	25	2.9
2.00 – 2.99	214	25.0
3.00 – 3.99	545	63.7
4.00 – 4.71	72	8.4
High School Math GPA		
0.50 – 1.99	150	18.1
2.00 – 2.99	339	40.9
3.00 – 3.99	283	34.2
4.00	56	6.8
Highest ACT Math		
13 – 16	276	33.0
17 – 18	238	28.4
19 – 21	158	18.9
22 - 30	165	19.7
Highest SAT Math		
260 – 390	26	26.5
400 – 430	25	25.5
440 – 490	25	25.5
500 - 640	22	22.4

n = 856

Major Findings

This study investigated four research questions. The major findings are organized and presented in response to each question. The discussion includes (1) developmental performance, student attributes, and high school performance measures; (2) college-level performance, student attributes, and high school performance measures; (3) developmental success, college-level math, student attributes, and high school performance measures; and (4) college-readiness and first-year to second-year retention.

Developmental Performance, Student Attributes, and Performance Measures

For Research Question 1 (Which high school measures and student attributes best predict performance in remedial math for graduates of West Virginia public high schools enrolling at Marshall University?), student attributes and high school performance measures were analyzed as they related to student success in MTH 098 (Basic Skills in Mathematics I) and MTH 099 (Basic Skills in Mathematics II) and also for success in MTH 099 for those students who first succeeded in MTH 098 to gain entry into MTH 099. These data are organized by student attributes and high school performance measures.

There were seven student attributes identified as independent variables and analyzed in consideration of success or lack of success in MTH 098 (Basic Skills in Mathematics I) and MTH 099 (Basic Skills in Mathematics II). These attribute variables included sex, ethnicity, Pell Grant eligibility, the father's educational level, the mother's educational level, unmet need, and estimated family contribution. For the purpose of analysis, categories within the variables of ethnicity, father's educational level, and mother's educational level were collapsed into two categories as a result of data cell sizes less than five. Overall high school GPA, high school math GPA, highest ACT Mathematics score, highest SAT Math score, high school attendance percentage, unmet financial need, and estimated family contribution (EFC) were also analyzed to determine if there were any differences in success or failure in MTH 098 and MTH 099 based on each of the variables.

Student Attribute Variables

An analysis of the demographic variables for all students enrolling in MTH 098 is presented in Table 6. A chi-square goodness of fit test was performed on each categorical independent variable presented in Table 6. The analyses revealed statistically significant differences between performance in MTH 098 for one categorical independent variable (Pell Grant Eligibility, $p = .03$). Students who were eligible for Pell Grant assistance (55.4%) succeeded in MTH 098 at a lower rate than students who were not eligible for Pell Grant (69.4%).

Unmet need and the estimated family contribution are continuous variables but are also considered student attributes. An independent samples t-test revealed a significant difference ($p = .04$) in the estimated family contribution for those who succeeded in MTH 098 (M = 8,022.25, SD = 15,321.62) and those who were not successful (M = 4,756.53, SD = 9,802.80). There was also a significant difference in the unmet need ($p = .00$) for those who were successful or not successful in MTH 098. Students successful in MTH 098 reflected a lesser unmet need (M = 2,100.23, SD = 3028.84) than those students who did not succeed (M = 3,566.70, SD = 3,984.32).

Table 6. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 098 (Basic Skills in Mathematics 1)

Demographic Variables	MTH 098 Success *n*	%	MTH 098 Failure *n*	%	X^2	*p*
Sex					.51	.48
Male	52	57.1	39	42.9		
Female	100	61.7	62	38.3		
Ethnicity					.00	.95
White	97	63.4	56	36.6		
Black	16	64.0	9	36.0		
Pell Grant Eligibility					4.59	.03
Eligible	92	55.4	74	44.6		
Not Eligible	59	69.4	26	30.6		
Father's Educational Level					.01	.93
High School or Lower	96	60.8	62	39.2		
College or Beyond	46	61.3	29	38.7		
Mother's Educational Level					.16	.69
High School or Lower	74	57.8	54	42.2		
College or Beyond	64	60.4	42	39.6		

n = 856

An analysis of the demographic variables for all students enrolling in MTH 099 are presented in Table 7. A chi-square goodness of fit test was performed on each categorical independent variable presented in Table 7. The analyses revealed statistically significant differences between performances in MTH 099 for one categorical independent variable (Ethnicity, $p = .01$). White students (60.7%) succeeded in MTH 099 at a higher rate than black students (39.5%)

There was also a significant difference in in the student performance in MTH 099 based on the level of unmet need ($p = .00$). Students who succeeded had a lower unmet need (M = 1,762.51, SD = 3,293.57) when compared to students who did not succeed (M = 3,350.40, SD =

4,149.46). There was no significant difference in the students' estimated family contributions for those students who succeeded or did not succeed in MTH 099.

Table 7. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 099 (Basic Skills in Mathematics II)

Demographic Variables	MTH 099 Success		MTH 099 Failure			
	n	%	*n*	%	X^2	*p*
Sex					.09	.77
Male	81	58.3	58	41.7		
Female	151	56.8	115	43.2		
Ethnicity					6.19	.01
White	164	60.7	106	39.3		
Black	15	39.5	23	60.5		
Pell Grant Eligibility					.77	.38
Eligible	132	55.5	106	44.5		
Not Eligible	97	59.9	65	40.1		
Father's Educational Level					2.08	.15
High School or Lower	141	55.3	114	44.7		
College or Beyond	74	63.2	43	36.8		
Mother's Educational Level					1.82	.17
High School or Lower	117	54.4	98	45.6		
College or Beyond	100	61.3	63	38.7		

n = 856

Student High School Performance Measures

An independent-samples t-test was used to compare each continuous independent variable to the student's success or failure in MTH 098 (Basic Skills in Mathematics I) or MTH 099 (Basic Skills in Mathematics II). A summary of the analyses of the high school performance for all students enrolling in MTH 098 is presented in Table 8.

The independent-samples t-test revealed significant differences in performance in MTH 098 based on overall high school GPA (p = .00) and high school math GPA (p = 00). Students successful in MTH 098 (*M* = 3.11, *SD* = .50) reflected a higher overall high school GPA than those who were not successful (*M* = 2.73, *SD* = .52). Students successful in MTH 098 (*M* = 2.43, *SD* = .69) also reflected a higher high school math GPA than those who were not successful (*M* = 2.11, *SD* = .63). No significant difference in performance in MTH 098 were found based on highest ACT Mathematics score, highest SAT Math score, or the high school attendance rate.

Table 8. Independent Samples T-test Results from Comparison of High School Performance Measures for Success in MTH 098 (Basic Skills in Mathematics I)

	MTH 098 Success			MTH 098 Failure				
Performance	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
Overall HS GPA	152	3.11	.50	101	2.73	.52	5.80	.00
HS Math GPA	147	2.43	.69	94	2.11	.63	3.63	.00
ACT Math	149	15.70	.96	94	15.56	.65	1.20	.24
SAT Math	10	342	44.42	6	366.67	35.02	-1.16	.27
HS Attendance	96	.93	.06	63	.91	.08	1.87	.09

n = 856

Additional independent-samples t-tests were performed for all students enrolling in MTH 099. A summary of the analyses of the high school performance for all students enrolling in MTH 099 is presented in Table 9. There were significant differences in performance based on overall high school GPA (*p* = .00), high school math GPA (*p* = .00), and the highest ACT Mathematics score (*p* = .05). Students successful in MTH 099 (*M* = 3.25, *SD* = .47) reflected a higher overall high school GPA than those students who were not successful (*M* = 2.94, *SD* = .48). The high school math GPA was also higher for those students who were successful in MTH 099 (*M* = 2.64, *SD* = .67) than those who were not successful (*M* = 2.23, *SD* = .60). There was a significant difference in the ACT Mathematics score for those who were successful in MTH 099 (*M* = 15.95, *SD* = 1.03) and those who did not succeed (*M* = 15.50, *SD* = .73). There were no significant differences in performance based on highest SAT Math score or high school attendance percentage.

Table 9. Independent Samples T-test Results from Comparison of High School Performance Measures for Success in MTH 099 (Basic Skills in Mathematics II)

	MTH 099 Success			MTH 099 Failure				
Performance	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
Overall HS GPA	74	3.25	.47	64	2.94	.48	3.82	.00
HS Math GPA	73	2.64	.67	60	2.23	.60	3.73	.00
ACT Math	74	15.95	1.03	60	15.50	.73	2.83	.05
SAT Math	4	350.00	21.60	3	343.33	64.30	.20	.85
HS Attendance	45	.93	.05	40	.92	.07	1.14	.26

n = 856

Analyzing Success in MTH 099 after First Succeeding in MTH 098

Some students may directly enter MTH 099 based on initial placement scores, but other students might initially be placed in MTH 098. Those students must succeed in MTH 098 (Basic Skills in Mathematics I) before entering MTH 099 (Basis Skills in Mathematics II). Additional analyses provide a summary of those students who first enroll in MTH 098 and continue their enrollment in MTH 099.

Student Attribute Variables

The demographic data for students who initially enrolled in MTH 098 and then progressed to MTH 099 are summarized in Table 10. A chi-square goodness of fit analysis revealed a significant difference in the ethnicity (p = .05) between students who succeeded in MTH 099 after succeeding in MTH 098 and those who did not succeed. White students (60.0%) succeeded at a higher rate than black students (30.8%). There were no significant differences in

MTH 099 performance for sex, Pell Grant eligibility, father's education level, or mother's educational level.

An independent samples t-test was performed on the estimated family contribution and the unmet need of those students who entered MTH 099 after first succeeding in MTH 098. There was no significant difference in performance in MTH 099 based on either the estimated family contribution or the unmet need for those students who successfully completed MTH 098.

Table 10. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 099 (Basic Skills in Mathematics II) after Student Success in MTH 098 (Basic Skills in Mathematics I)

Demographic Variables	MTH 099 Success		MTH 099 Failure			
	n	%	*n*	%	X^2	*p*
Sex					1.59	.21
Male	26	61.9	16	38.1		
Female	41	50.0	41	50.0		
Ethnicity					3.88	.05
White	48	60.0	32	40.0		
Black	4	30.8	9	69.2		
Pell Grant Eligibility					.012	.91
Eligible	40	54.1	34	45.9		
Not Eligible	26	53.1	23	46.9		
Father's Educational Level					1.28	.26
High School or Lower	38	49.4	39	50.6		
College or Beyond	23	60.5	15	39.5		
Mother's Educational Level					.00	.98
High School or Lower	33	54.1	28	45.9		
College or Beyond	28	53.8	24	46.2		

n = 856

Student High School Performance Measures

Table 11 reveals the results of independent-sample t-tests performed on each of the high school performance measures against success or failure in MTH 099 for those students who had initially succeeded in MTH 098 before progressing to MTH 099. Students who succeeded in MTH 099 after first succeeding in MTH 098 had a significantly higher (p = .00) overall high school GPA (M = 3.26, SD = .48) than those who did not succeed (M = 2.97, SD = .48). There was also a significant difference (p = .00) in the high school math GPA for those students who succeeded (M = 2.66, SD = .68) and those who did not succeed (M = 2.20, SD = .61). The t-test on the ACT Mathematics score also revealed a significant difference (p = .01) in success (M = 15.94, SD = 1.09) and failure in MTH 099 (M = 15.50, SD = .74). There were no significant differences in the performance in MTH 099 based on the highest SAT Math score or the high school attendance percentage for those students who had successfully completed MTH 099.

Table 11. Independent Samples T-test Results from Comparison of High School Performance for Success in MTH 099 (Basic Skills in Mathematics II) after Student Success in MTH 098 (Basic Skills in Mathematics I)

	Success			Failure				
Performance	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
Overall HS GPA	67	3.26	.48	57	2.97	.48	3.37	.00
HS Math GPA	66	2.66	.68	53	2.20	.61	3.83	.00
ACT Math	67	15.94	1.09	56	15.50	.74	2.58	.01
SAT Math	4	350	21.60	3	343.22	64.29	.20	.85
HS Attendance	40	.93	.05	35	.92	.07	1.00	.32

n = 856

In summary, the chi-square goodness of fit analysis revealed a significant difference for performance in MTH 098 based on Pell Grant eligibility (p = .03). An independent samples t-test revealed a significant difference in performance in MTH 098 based on unmet need (p = .00) and the estimated family contribution (*p* =.04). Additional independent samples t-tests revealed significant differences in performance in MTH 098 based upon overall high school GPA (*p* = .00) and high school math GPA (*p* = .00).

The chi-square goodness of fit analyses revealed a significant difference in performance based on ethnicity for those students who succeeded in MTH 099 (*p* = .01). An independent samples t-test revealed a significant difference in performance in MTH 099 based on unmet need (*p* = .00). Additional independent samples t-tests revealed significant differences in performance in MTH 099 based on overall high school GPA (*p* = .00), high school math GPA (*p* = .00), highest ACT Mathematics score (*p* = .05), and high school attendance percentage (*p* = .05).

The chi-square goodness of fit analysis revealed a significant difference in performance based on ethnicity for those students who succeeded in MTH 099 after first succeeding in MTH 098 (*p* = .05). Performance in MTH 099 for students who first succeeded in MTH 098 was significantly influenced by overall high school GPA (*p* = .00), high school math GPA (*p* = .00), and highest ACT Mathematics score (*p* = .01).

College-Level Performance, Student Attributes, and Performance Measures

For Research Question 2 (Which high school performance measures and student attributes best predict college readiness for math for graduates of West Virginia public high schools enrolling at Marshall University?), the same seven demographic variables and the same five high school performance measures as used to analyze the developmental math performance were used to analyze the differences in success and failure in college-level math courses. These attribute variables included sex, ethnicity, Pell Grant eligibility, the father's educational level, the mother's educational level, unmet need, and estimated family contribution. For the purpose of analysis, categories within the variables of ethnicity, father's educational level, and mother's educational level were collapsed into two categories as a result of data cell sizes less than five. Overall high school GPA, high school math GPA, highest ACT Mathematics score, highest SAT Math score, and high school attendance percentage were also analyzed to determine if there were any differences based on success or failure in the college-level courses.

At the time of this study, students who were determined to be college-ready by the state-determined cut scores directly entered MTH 121 Concepts and Applications, MTH 127 College Algebra Expanded, or MTH 130 College Algebra. MTH 121 was the determined pathway for academic majors not requiring algebra while, as the course names reflect, MTH 127 and MTH 130 were pathways established for majors requiring algebra. MTH 121, MTH 127, and MTH 130 are letter-graded and outcomes reflect the successful results of the letter grades of A, B, or C, and the unsuccessful results of D, F, or W combined.

Student Attribute Variables

The data for each demographic variable compared to the MTH 121 outcomes are provided in Table 12. A chi-square goodness of fit test was performed on each categorical independent variable and data are presented in Table 12. There were significant differences based on one variable, Pell Grant Eligibility (p = .02), in the four levels of performance in MTH 121. Students receiving a grade of A in MTH 121 were more likely to not be eligible for Pell Grant than those who were eligible (eligible, 19.3%; not eligible, 43.1%). Pell Grant eligible students were more likely to receive a grade of D, F, or W than those who were not eligible (eligible, 30.0%; not eligible, 22.3%)

A one-way between-groups analysis of variance performed on the student financial attributes revealed there were significant differences in performance in MTH 121 based on the estimated family contribution (p = .02) and the unmet need (p = .00). The Tukey HSD test revealed that the mean unmet need for students who received a grade of A (*M* = -597.15, *SD* = 3,800.69), a grade of B (*M* = 858.37, *SD* = 3,701.48) or a grade of C (*M* = 339.69, *SD* = 2,889.10) in MTH 121 differed significantly only from the mean unmet need for those students who received a grade of D, F, or W (*M* = 2,745.65, *SD* = 3,493.77). The Tukey HSD indicated that the mean estimated family contribution for students who received a grade of A (*M* = 11,910.09, *SD* = 16,527.54) in MTH 121 differed significantly only from the mean estimated family contribution of those students who received a grade of D, F, or W (*M* = 5,448.63, *SD* = 11,642.76). There were no significant differences in the mean score of students who received a grade of B (*M* = 7,536.62, *SD* = 9,204.36) or those students receiving a grade of C (*M* = 11,935.77, *SD* = 17,797.73) and the mean estimated family contribution of students who received any other grade, D, F, or W (*M* = 5,448.63, *SD* = 11,642.76).

Table 12. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 121 (Concepts and Applications)

Demographics	Grade = A *n*	Grade = A %	Grade = B *n*	Grade = B %	Grade = C *n*	Grade = C %	Grade = D, F, W *n*	Grade = D, F, W %	X^2	*p*
Sex									2.93	.40
Male	19	24.4	21	26.9	18	23.1	20	25.6		
Female	51	27.0	64	33.9	29	15.3	45	23.8		
Ethnicity									5.13	.16
White	57	30.5	58	31.0	36	19.3	36	19.3		
Black	4	22.2	6	33.3	1	5.6	7	38.9		
Pell Grant Eligibility									10.24	.02
Eligible	27	19.3	48	34.3	23	16.4	42	30.0		
Not Eligible	43	34.1	36	39.8	24	22.3	24	22.3		
Father's Ed. Level									.95	.81
HS or Lower	42	25.8	55	33.7	27	16.6	39	23.9		
College/Beyond	24	29.3	24	29.3	16	19.5	18	22.0		
Mother's Ed. Level									4.30	.23
HS or Lower	27	20.8	44	36.9	25	19.2	30	23.1		
College/Beyond	39	31.7	37	30.1	19	15.4	28	22.8		

n = 856

The data for each demographic variable compared to the MTH 127 outcomes are provided in Table 13. A chi-square goodness of fit test was also performed on each independent variable. Statistically significant differences were found in student performance in MTH 127 based on sex (*p* = .02). A larger percentage of females than males earned As (females, 24.4%; males, 14.0%) and Bs (females, 29.8%; males, 20.0%), and a higher percentage of males than females earned Cs (females, 20.06%; males, 32.0%). An independent samples t-test on the student financial attributes revealed that neither the estimated family contribution nor the unmet need had any significant influence on student performance in MTH 127.

Table 13. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 127(College Algebra Expanded)

Demographics	Grade = A *n*	%	Grade = B *n*	%	Grade = C *n*	%	Grade = D, F, W *n*	%	$X^{2(1)}$	*p*
Sex									9.61	.02
Male	14	14.0	20	20.0	32	32.0	34	34.0		
Female	32	24.4	39	29.8	27	20.6	33	25.2		
Ethnicity									4.54	.21
White	35	21.5	44	27.0	42	25.8	42	25.8		
Black	4	30.8	2	15.4	1	7.7	6	46.2		
Pell Grant Eligibility									3.98	.26
Eligible	26	22.2	26	22.2	26	22.2	39	33.3		
Not Eligible	19	17.1	32	28.8	32	28.8	28	32.6		
Father's Ed. Level									4.18	.24
HS or Lower	31	24.6	30	23.8	32	25.4	33	26.2		
College/Beyond	13	14.4	29	32.2	22	24.4	26	28.9		
Mother's Ed. Level									4.66	.20
HS or Lower	21	18.4	37	32.5	28	24.6	28	24.5		
College/Beyond	22	21.0	21	20.0	28	26.7	34	32.4		

n = 856

For MTH 130, the data in Table 14 revealed that one demographic variable had any significant influence on the performance levels in that course. Only the mother's educational level (*p* = .00) was significant. Students whose mothers attended college or beyond were more likely to receive a grade of A in MTH 130 than students whose mothers achieved a lower level of education (college/beyond, 27%; high school or lower, 21.3%). Students whose mothers attended college or beyond were much less likely to receive a grade of D, F, or W (college/beyond, 14.9%; high school or lower, 47.5%).

A one-way between-groups analysis of variance performed on the student financial attributes revealed a statistically significant difference in performance in MTH 130 based on the unmet need (p = .00). The Tukey HSD test revealed that the mean unmet need of the students who received a grade of A (M = -2,082.29, SD = 4,511.87) or a B (M = -2,576.51, SD = 4,118.20) in MTH 130 differed significantly from those who received a grade of D, F, or W (M = 1,181.22, SD = 5,270.44), but did not significantly differ from the mean unmet need of each other or the mean unmet need of those students who received a grade of C (M = 288.38, SD = 5,095.86). The mean unmet need for those students who received a grade of D, F, or W was significantly different from the mean unmet need of the students who received a grade of A or B, but not C. There were no significant differences in performance in MTH 130 based on levels of estimated family contribution.

Table 14. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 130 (College Algebra)

Demographics	Grade = A *n*	Grade = A %	Grade = B *n*	Grade = B %	Grade = C *n*	Grade = C %	Grade = D, F, W *n*	Grade = D, F, W %	X^2	*p*
Sex									3.34	.34
Male	13	20.6	11	17.5	16	25.4	23	36.5		
Female	21	27.3	20	26.0	16	20.8	20	26.0		
Ethnicity									.95	.81
White	27	26.2	21	20.4	26	25.2	29	28.2		
Black	3	37.5	2	25.0	1	12.5	2	25.0		
Pell Grant Eligibility									2.38	.50
Eligible	13	24.5	10	18.9	10	18.9	20	37.7		
Not Eligible	21	24.1	21	24.1	22	25.3	23	26.4		
Father's Ed. Level									6.46	.09
HS or Lower	16	22.5	14	19.7	12	16.9	29	40.9		
College/Beyond	18	28.6	16	25.4	16	25.4	13	20.6		
Mother's Ed. Level									17.85	.00
HS or Lower	13	21.3	10	16.4	9	14.8	29	47.5		
College/Beyond	20	27.0	21	28.4	22	29.7	11	14.9		

n = 856

Student High School Performance Measures

A one-way between-groups analysis of variance (ANOVA) was performed to analyze the means and determine the influence of five independent high school performance variables on student performance in MTH 121 (Concepts and Applications), MTH 127 (College Algebra Expanded), and MTH 130 (College Algebra). Data from these analyses are included in Tables 15, 16, and 17, respectively.

Data in Table 15 reflect the results of a one-way between groups analysis of variance for each of the high school performance and financial variables and their influence on the MTH 121 performance outcomes. There were statistically significant differences at the $p \leq .05$ level for four of the five performance variables: high school GPA ($F = 20.35$, $p = .00$); high school math GPA ($F = 16.37$, $p = .00$); highest ACT Mathematics score ($F = 18.75$, $p = .00$); and high school attendance percentage ($F = 2.83$, $p = .04$). There were no statistically significant differences in performance in MTH 121 based on the highest SAT math score.

Post hoc comparisons using the Tukey HSD test indicated that the mean high school GPA for students who received a grade of A in MTH 121 ($M = 3.71$, $SD = .45$) was significantly different from students receiving a grade of B ($M = 3.39$, $SD = .43$), students who received a grade of C ($M = 3.21$, $SD = .44$), and students who received grades of D, F, or W ($M = 3.15$, $SD = .47$). Mean high school GPAs for students who received a grade of B differed significantly from the means of those students receiving an A or D, F, or W, but not from those who received a C. The mean GPA for those students who received a C differed significantly only for those students who received a grade of A. The mean GPA for grades of D, F, or W differed from means scores for A and B, but not C.

The Tukey HSD test indicated that the mean high school math GPA for students who achieved an A in MTH 121 ($M = 3.20$, $SD = .76$) differed significantly from the mean high school math GPA of those students who received a grade of B ($M = 2.68$, $SD = .66$), a grade of C ($M = 2.40$, $SD = .79$), and grades of D, F, or W ($M = 2.45$, $SD = .73$). The mean high school math GPA for those students who received a grade of B in MTH 121 was significantly different from the mean high school math GPA for those students who received an A, but not for those students who received a C or D, F, or W. The mean high school math GPA for students who received a grade of C in MTH 121 differed significantly from the mean high school math GPA of those students who received a grade of A, but not a B or D, F, or W. Mean high school math

GPA for those students who received a D, F, or W differed significantly only with those mean high school math GPAs of those students who received an A.

The Tukey HSD test found that mean ACT Mathematics scores for students who received a grade of A (*M* = 21.14, *SD* = 3.05) in MTH 121 differed significantly from the mean ACT Mathematics scores for students who received a grade of B (*M* = 18.61, *SD* = 2.71), students who received a grade of C (*M* = 18.28, *SD* = 2.75), and students who received a grade of D, F, or W (*M* = 17.94, *SD* = 2.44). The mean ACT Mathematics scores for students who received a B in MTH 121 differed significantly from the mean scores for students who received an A, but not a C or D, F, or W. The mean ACT Mathematics scores for students who received a C or a D, F, or W in MTH 121 differed significantly only with the mean ACT Mathematics score for students who received an A.

The post hoc Tukey HSD comparison revealed that the mean high school attendance percentages for students who received an A in MTH 121 (*M* = .95, *SD* = .04) differed significantly only from the mean high school attendance percentages of those students who received a D, F, or W in MTH 121 (*M* = .92, *SD* = .06). The mean high school attendance percentages for those students who received an A did not differ significantly from the mean high school attendance percentages of those students who received a grade of B (*M* = .93, *SD* = .04) or a grade of C (*M* = .94, *SD* = .03). The mean high school attendance percentage for students who received a B or C in MTH 121 did not differ significantly from any other group. The mean high school attendance percentage for students who received a D, F, or W only differed significantly from the mean percentage of those students who received a grade of A.

Table 15. One-Way Between-Groups Analysis of Variance Results from Comparison of High School Performance Measures for Success in MTH 121(Concepts and Applications)

Performance	Grade = A			Grade = B			Grade = C			Grade = D, F, W				
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M(n)*	*SD*	*F*	*p*
HS GPA	70	3.71	.45	85	3.39	.43	47	3.21	.44	65	3.15	.47	20.35	.00
HS Math GPA	70	3.20	.76	84	2.68	.66	47	2.40	.79	63	2.45	.73	16.37	.00
ACT Math Score	70	21.14	3.05	85	18.61	2.71	46	18.28	2.75	62	17.94	2.44	18.75	.00
SAT Math Score	10	478.00	87.66	69	417.69	44.38	5	426.00	49.80	9	423.33	43.59	2.23	.10
HS Attendance	48	.95	.04	58	.93	.04	28	.94	.03	48	.92	.06	2.83	.04

n = 856

Data in Table 16 reveal the results of a one-way between groups analysis of variance for each of the high school performance and financial variables and their influence on the MTH 127 performance outcomes. There were statistically significant differences at the $p \leq .05$ level for the means of four of the five performance variables: high school GPA ($F = 13.73$, $p = .00$); high school math GPA ($F = 11.44$, $p = .00$); highest ACT Mathematics score ($F = 2.79$, $p = .04$); and high school attendance percentage ($F = 2.92$, $p = .04$). There were no statistically significant differences in performance in MTH 127 based on the highest SAT math score.

The Tukey HSD test indicated that the means of the high school GPA for students who received a grade of A ($M = 3.62$, $SD = .36$) in MTH 127 differed significantly from the mean high school GPAs of those students who received a grade of C ($M = 3.28$, $SD = .48$) or a grade of D, F, or W ($M = 3.06$, $SD = .53$). There was not significant difference in the means for the students who received a grade of B ($M = 3.40$, $SD = .45$). For students who received a grade of B in MTH 127, there was only a significant different in the means with the students who received a grade of D, F, or W. For students who received a grade of C, the means differed significantly with only those who received a grade of A. The mean high school GPA for the students who received a grade of D, F, or W was significantly different than the means of those who received an A or B, but not a C.

A Tukey HSD test revealed that the high school math GPA means for students who received a grade of A ($M = 3.15$, $SD = .62$) in MTH 127 varied significantly from the high school math GPA means for students who received a grade of B ($M = 2.72$, $SD = .67$), a grade of C ($M = 2.76$, $SD = .68$), or D, F, or W ($M = 2.39$, $SD = .68$). For students who received a grade of B in MTH 127, the mean high school math GPA differed significantly from the means of those students who received a grade of A or D, F, or W, but not a grade of C. For students who received a grade of C, the mean high school math GPA varied significantly with the means of those students who received a grade of A or D, F, or W, but not a grade of B. For students who received a grade of D, F, or W, the mean high school math GPA differed significantly from the means of all other levels of performance.

The Tukey HSD test indicated that the mean ACT Mathematics score for students who received a grade of A (*M* = 19.02, *SD* = 2.74) in MTH 127 differed significantly only from the mean ACT Mathematics score of those students who received a grade of D, F, or W (*M* = 17.83, *SD* = 2.23). For those students who received an A, the mean ACT Mathematics score did not differ significantly from the mean ACT Mathematics score of those students who received grade of B (*M* = 18.17, *SD* = 2.11) or C (*M* = 18.59, *SD* = 2.12). For students who received a B or C in MTH 127, the mean ACT Mathematics score did not differ significantly from the means of students who received any other grade. The mean ACT Mathematics score for students who received a grade of D, F, or W differed significantly only from the means of those students who received a grade of A.

The Tukey HSD test found that mean high school attendance percentage for students who received a grade of A (*M* = .96, *SD* = .03) in MTH 127 differed significantly only from the mean high school attendance percentage of those students who received a grade of D, F, or W (M = .93, SD = .05). There was not a significant difference in the mean high school attendance percentage for those student who received a grade of B (M = .93, SD = .06) or C (M = .93, SD = .04). For students who received a grade of B or C, the mean high school attendance percentage did not differ significantly from the means of students who received any other grade. The mean high school attendance percentage for those students who received a grade of D, F, or W varied significantly only from the means of those students who received a grade of A.

Table 16. One-Way Between-Groups Analysis of Variance Results from Comparison of High School Performance Measures for Success in MTH 127(College Algebra Expanded)

Performance	Grade = A			Grade = B			Grade = C			Grade = D, F, W				
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M(n)*	*SD*	*n*	*M(n)*	*SD*	*F*	*p*
HS GPA	46	3.62	.36	59	3.40	.45	59	3.28	.48	67	3.06	.53	13.73	.00
HS Math GPA	45	3.15	.62	58	2.72	.67	56	2.76	.68	65	2.39	.68	11.44	.00
ACT Math Score	46	19.02	2.74	58	18.17	2.11	59	18.59	2.12	66	17.83	2.23	2.79	.04
SAT Math Score	4	445.00	78.53	9	480.00	66.33	8	406.25	67.81	5	416.00	79.88	1.74	.19
HS Attendance	26	.96	.03	43	.93	.06	33	.93	.04	42	.93	.05	2.92	.04

n = 856

Data in Table 17 reveal the results of a one-way between groups analysis of variance for each of the high school performance and financial variables and their influence on the MTH 130 performance outcomes. There were statistically significant differences at the $p \leq .05$ level for the means of three of the five performance variables: overall high school GPA (F = 18.59, p = .00); high school math GPA (F = 14.91, p = .00); and highest ACT Mathematics score (F = 7.67, p = .00). There were no statistically significant differences in performance in MTH 130 based on the highest SAT math score.

A Tukey HSD post hoc comparison reveals that the mean high school GPA for students who received a grade of A (M = 4.01, SD = .22) differed significantly from the mean high school GPA of those students who received grades of C (M = 3.68, SD = .39) or D, F, or W (M = 3.35, SD = .53) in MTH 130 but did not significantly differ from the mean high school GPA of those students who received a grade of B (M = 3.79, SD = .34). The mean high school GPA for those students who received a grade of B in MTH 130 differed significantly from the mean high school GPA of the students who received a grade of D, F, or W, but not the means of those who received a grade of A or C. The mean high school GPA for students who received a grade of C varied significantly from the mean high school GPA of those students who received a grade of A or D, F, or W, but not B. The mean high school GPA for those students who received a grade of D, F, or W in MTH 130 differed significantly from the mean high school GPA in all other performance levels.

The Tukey HSD test revealed that the mean high school math GPA for students who received a grade of A (M = 3.68, SD = .47) in MTH 130 differed significantly from the mean high school math GPA of those students who received a grade of C (M = 3.00, SD = .77) or D, F, or W (M = 2.71, SD = .72) but did not differ significantly from the means of those students who received a grade of B (*M* = 3.32, *SD* = .57). The mean high school math GPA for those students who received a grade of B differed significantly only from the mean high school math GPA of those students who received a grade of D, F, or W. For students who received a grade of C, the mean high school math GPA differed only from the mean of those students who received an A. The mean high school math GPA for students who received a grade of D, F, or W differed significantly from the mean high school math GPA of the students who received a grade of A or B, but not C.

The Tukey HSD test indicated that the mean ACT Mathematics score for students who received a grade of A (*M* = 24.39, *SD* = 2.66) in MTH 121 differed significantly from the mean math ACT of those students who received a grade of B (*M* = 22.68, *SD* = 1.87), a grade of C (*M* = 22.42, *SD* = 1.56), or a grade of D, F, or W (*M* = 22.33, *SD* = 1.91). The mean ACT Mathematics score of students who received a grade of B differed significantly from the mean ACT Mathematics score of students who received a grade of A, but not C or D, F, or W. The mean ACT Mathematics score of students who received a grade of either a C or a D, F, or W differed significantly from the mean ACT Mathematics score of those students who received a grade of A, but the means did not differ significantly between each other or a grade of B.

Table 17. One-Way Between-Groups Analysis of Variance Results from Comparison of High School Performance Measures for Success in MTH 130 (College Algebra)

	Grade = A			Grade = B			Grade = C			Grade = D, F, W				
Performance	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*F*	*p*
HS GPA	34	4.01	.22	31	3.79	.34	32	3.68	.39	43	3.35	.53	18.59	.00
HS Math GPA	33	3.68	.47	29	3.32	.57	32	3.00	.77	42	2.71	.72	14.91	.00
ACT Math Score	33	24.39	2.66	31	22.68	1.87	31	22.42	1.56	42	22.33	1.91	7.67	.00
SAT Math Score	9	530.00	62.25	5	488.00	62.21	4	497.50	9.57	4	480.00	57.16	1.04	.40
HS Attendance	27	.95	.03	21	.95	.04	22	.96	.03	29	.93	.05	2.20	.09

n = 856

In summary, the chi-square goodness of fit analysis revealed a significant difference for performance in MTH 121 (Concepts and Applications) based on Pell Grant eligibility (p = .02), in performance in MTH 127 (College Algebra Expanded) based on sex (p = .02), and in performance in MTH 130 (College Algebra) based on the mother's educational level (p = .00). The results of a one-way between-groups analysis of variance revealed differences in performance in MTH 121 based on unmet need (p = .00) and the estimated family contribution (p = .02). For MTH 130, there was a significant difference in performance based on unmet need (p = .00).

A one-way between-groups analysis of variance revealed significant differences on performance in MTH 121 for four of five high school performance measures: overall high school GPA (p = .00); high school math GPA (p = .00); highest ACT Mathematics score (p = .00); and high school attendance (p = .04). The one-way between-groups analysis of variance also revealed significant difference in performance in MTH 127 for the same four of five high school performance measures: overall high school GPA (p = .00); high school math GPA (p = .00); highest ACT Mathematics score (p = .04); and high school attendance (p = .04). For MTH 130, three of five measures were significant: overall high school GPA (p = .00); high school math GPA (p = .00); and highest ACT Mathematics score (p = .00).

Developmental Success, College-Level Math, Student Attributes, and Performance Measures

For Research Question 3 (For students who succeed in remedial math, which high school performance measures and student attributes best predict success in college-level math for graduates of West Virginia public high schools enrolling at Marshall University?), students who were successful in remedial MTH 099 Basic Skills in Mathematics II and progressed to enroll in either MTH 121 Concepts and Applications or MTH 127 College Algebra Expanded were identified. It is possible that students who were successful in MTH 099 may have started in MTH 098; however, once students achieved success in MTH 099, students were considered to have achieved equivalent levels of success in remedial math. Consequently, they were not segregated in the analysis. These data are organized by student attributes and high school performance measures.

It is also important to note that MTH 130 represents a direct path to college algebra for those students who meet a specific cut score (ACT Mathematics = 21 or SAT Mathematics = 500) and do not initially require developmental math; therefore, performance in MTH 130 cannot be analyzed in response to Research Question 3.

Student Attribute Variables

The data for each demographic variable compared to the MTH 121 outcomes after a student succeeds in MTH 099 are provided in Table 18. For the purpose of analysis, variables with cell sizes less than five were collapsed into two categories. Collapsed categories include ethnicity, father's educational level, and mother's educational level. The five performance variables include high school GPA, high school math GPA, Pell Grant eligibility, the father's educational level and the mother's educational level.

A chi-square goodness of fit test was performed on each categorical independent variable presented in Table 18. No significant differences were found in the level of performance in MTH 121 after first succeeding in MTH 099 based on any of the categorical variables. A one-way between-groups analysis of variance (ANOVA) was performed to analyze the means and determine the influence of the financial attributes on the four outcomes of students enrolled in

MTH 121 after achieving success in MTH 099. No significant differences were found in performance based on family contribution or unmet need.

Table 18. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 121 (Concepts and Applications) after Student Success in MTH 099 (Basic Skills in Mathematics II)

	Grade = A		Grade = B		Grade = C		Grade = D, F, W			
Characteristic	*n*	%	*n*	%	*n*	%	*n*	%	X^2	*p*
Sex									.59	.90
Male	6	22.2	10	37.0	5	18.6	6	22.2		
Female	12	17.1	26	37.1	12	17.1	20	28.7		
Ethnicity									2.95	.40
White	14	20.0	24	34.3	16	22.9	16	22.8		
Black	2	28.6	4	57.1	0	0.0	1	14.3		
Pell Grant Eligibility									1.13	.77
Eligible	10	18.2	19	34.5	9	16.4	17	30.9		
Not Eligible	8	19.0	17	40.5	8	19.0	9	21.5		
Father's Ed. Level									2.26	.52
HS or Lower	14	23.0	21	34.4	9	14.8	17	27.8		
College/Beyond	3	11.5	12	46.2	5	19.2	6	23.1		
Mother's Ed. Level									2.68	.44
HS or Lower	7	15.6	16	35.6	8	17.8	14	31.0		
College/Beyond	10	22.2	20	44.4	7	15.6	8	17.8		

n = 856

The data for MTH 127 outcomes after a student succeeds in MTH 099 are provided in Table 19. A chi-square goodness of fit test was also performed on each independent variable. No significant differences were found in the level of performance in MTH 127 after first succeeding in MTH 099 based on any of the selected categorical variables. A one-way between-groups analysis of variance (ANOVA) was performed to analyze the means and any differences based on the financial attributes on the four outcomes for students enrolled in MTH 127 after achieving success in MTH 099. No significant differences were found.

Table 19. Chi-Square Results from Comparison of Demographic Variables for Success in MTH 127 (College Algebra Expanded) after Student Success in MTH 099 (Basic Skills in Mathematics II)

	Grade = A		Grade = B		Grade = C		Grade = D, F, W			
Characteristic	*n*	%	*n*	%	*n*	%	*n*	%	X^2	*p*
Sex									4.37	.23
Male	9	23.7	6	15.8	12	31.6	11	28.9		
Female	15	23.1	22	33.8	15	23.1	13	20.0		
Ethnicity									1.20	.57
White	18	24.7	22	30.1	19	26.0	14	19.2		
Black	3	42.9	1	14.3	1	14.3	2	28.5		
Pell Grant Eligibility									3.72	.29
Eligible	16	28.6	13	23.2	16	28.6	11	19.6		
Not Eligible	7	15.9	14	31.8	10	22.7	13	29.6		
Father's Ed. Level									4.42	.22
HS or Lower	17	29.8	16	28.1	15	26.3	9	15.8		
College/Beyond	6	15.0	12	30.0	10	25.0	12	30.0		
Mother's Ed. Level									4.10	.25
HS or Lower	14	26.4	17	32.1	14	26.4	8	15.1		
College/Beyond	9	20.5	10	22.7	11	25.0	14	31.8		

n = 856

Student High School Performance Measures

A one-way between-groups analysis of variance (ANOVA) was performed to analyze the means and determine the influence of five independent high school performance measures on the four outcomes of students enrolled in MTH 121 and MTH 127 after achieving success in MTH 099. Data from these analyses are included in Table 20.

There was a statistically significant difference at the $p \leq .05$ level for one of the five performance variables, the high school GPA ($F = 4.27$, $p = .01$), when compared to MTH 121 performance. Post hoc comparisons using the Tukey HSD test indicated that the mean high school GPA for students who received a grade of A ($M = 3.45$, $SD = .42$) in MTH 121 after achieving success in MTH 099 was significantly different from students who received a grade of D, F, or W ($M = 3.06$, $SD = .60$). There was no significant difference in the mean high school GPA for students who received a grade of A and those students who received a grade of B ($M = 3.44$, $SD = .36$) or students who received grades of C ($M = 3.27$, $SD = .36$). Mean high school GPAs for students who received a grade of B differed significantly from the mean of those students who received a grade of D, F, or W, but not from those who received an A or C. The mean GPA for those students who received a C did not differ significantly from any other performance levels. The mean GPA for grades of D, F, or W differed from means scores for A and B, but not C.

Data in Table 20 also reflect the results of a one-way between groups analysis of variance for each of the high school performance and financial variables and their influence on the MTH 127 performance outcomes after a student has succeeded in MTH 099. There was a statistically significant difference at the $p \leq .05$ level for the mean high school GPA ($F = 7.75$, $p = .00$) and the mean high school math GPA ($F = 6.71$, $p = .00$). The means of the other variables did not differ significantly in the performance levels in MTH 127.

A Tukey HSD post hoc comparison reveals that the mean high school GPA for students who received a grade of A ($M = 3.50$, $SD = .40$) differed significantly from the mean high school GPA of those students who received grades of D, F, or W ($M = 2.87$, $SD = .51$) in MTH 127 after succeeding in MTH 099 but did not significantly differ from the mean high school GPA of those students who received a grade of B (*M* = 3.37, *SD* = .51) or C (*M* = 3.24, *SD* = .47). The mean high school GPA for those students who received a grade of B in MTH 127 after achieving success in MTH 099 differed significantly from the mean high school GPA of the students receiving a grade of D, F, or W, but not the means of those who received a grade of A or C. The mean high school GPA for students receiving a grade of C varied significantly from the mean high school GPA of those students who received a grade of D, F, or W, but not an A or B. The mean high school GPA for those students who received a grade of D, F, or W differed significantly from the mean high school GPA in all other performance levels.

The Tukey HSD test revealed that the mean high school math GPA for students who received a grade of A (*M* = 2.98, *SD* = .65) in MTH 127 after achieving success in MTH 099 differed significantly from the mean high school math GPA of those students who received a grade of D, F, or W (*M* = 2.17, *SD* = .68) but did not differ significantly from the means of the students who received a grade of B (*M* = 2.64, *SD* = .73) or a C (*M* = 2.87, *SD* = .64). The mean high school math GPA for those students who received a grade of B did not differ significantly from the mean high school math GPA at any other performance level. For students who received a grade of C, the mean high school math GPA differed only from the mean of those students who received a D, F, or W. The mean high school math GPA for students receiving a grade of D, F, or W differed significantly from the mean high school math GPA of the students receive a grade of A or C, but not B.

Table 20. One-Way Between-Groups Analysis of Variance Results from Comparison of Performance Measures for Success in MTH 121 (Concepts and Applications) after Student Success in MTH 099 (Basic Skills in Mathematics II) and Comparison of Performance Measures in MTH 127 (College Algebra Expanded) after Student Success in MTH 099 (Basic Skills in Mathematics II)

	MTH 121 Grade = A			MTH 121 Grade = B			MTH 121 Grade = C			MTH 121 Grade = D, F, W				
Performance	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M(n)*	*SD*	*F*	*p*
HS GPA	18	3.45	.42	36	3.44	.36	17	3.27	.36	26	3.06	.60	4.27	.01
HS Math GPA	18	2.91	.79	36	2.62	.61	17	2.54	.74	25	2.42	.82	1.65	.18
ACT Math Score	18	17.28	1.02	36	17.11	1.37	17	16.53	.80	26	16.77	1.21	1.60	.19
SAT Math Score	2	375.00	35.36	5	392.00	40.87	2	390.00	14.14	1	410.00	0.00	.21	.88
HS Attendance	11	.96	.02	23	.94	.04	10	.94	.04	19	.93	.06	.91	.44
	MTH 127 Grade = A			MTH 127 Grade = B			MTH 127 Grade = C			MTH 121 Grade = D, F, W				
HS GPA	24	3.50	.40	28	3.37	.51	27	3.24	.47	24	2.87	.51	7.75	.00
HS Math GPA	23	2.98	.65	28	2.64	.73	24	2.87	.64	24	2.17	.68	6.71	.00
ACT Math Score	24	17.17	1.13	28	17.04	1.35	27	17.04	1.40	24	16.54	1.18	1.13	.34
SAT Math Score	2	395.00	91.92	3	426.67	15.28	4	430.00	42.43	2	350.00	84.85	1.09	.41
HS Attendance	11	.96	.03	22	.93	.06	11	.93	.05	13	.94	.05	1.02	.39

n = 856

In summary, there were no high school student attributes reflecting a significant influence on the performance level of students in MTH 121 (Concepts and Applications) or MTH 127 (College Algebra Expanded) after first succeeding in MTH 099 (Basic Skills in Mathematics II). A one-way between-groups analysis of variance revealed that only the overall high school GPA ($p = .01$) had a significant influence on the performance levels in MTH 121 for those students who first succeeded in MTH 099. The one-way between-groups analysis of variance revealed that the overall high school GPA ($p = .00$) and the high school math GPA ($p = .00$) had significant influence on the performance levels of students in MTH 127 who first succeeded in MTH 099.

College-Readiness and First- to Second-Year Retention

For Research Question 4 (Using college readiness in math as a filter, which high school performance measures and student attributes best predict first-year to second-year retention for graduates of West Virginia public high schools enrolling at Marshall University?), college readiness was defined as student success in either MTH 099 (Basic Skills in Mathematics II), MTH 121 (Concepts and Applications), MTH 127 (College Algebra Expanded), or MTH 130 (College Algebra). For MTH 099, success was defined as receiving a grade of CR (credit) in the course. For MTH 121, MTH 127, and MTH 130, success was defined as receiving a grade of A, B, or C. Once success in a math course was determined, enrollment data for the second fall semester after the cohort entered the case study institution were collected. For example, Cohort 1 entered the case study institution in Fall 2010. For the students who succeeded in the identified courses, the first-year to second-year retention was measured based on whether or not the student enrolled in Fall 2011. First- to second-year retention for Cohort 2 was measured in Fall 2012, for Cohort 3 in Fall 2013, for Cohort 4 in Fall 2014, and for Cohort 5 in Fall 2015.

Retention rates for students who were successful in either math course ranged from a low of 68.8% (MTH 130, Cohort 5) to a high of 95.1% (MTH 127, Cohort 2). Retention rates for students who were not successful in either math course ranged from a low of 4.9% (MTH 127, Cohort 2) to a high of 31.2% (MTH 130, Cohort 5). Retention data by math course and cohort are presented in Table 21.

Table 21. Fall-to-Fall Retention Filtered by College-Readiness as Determined by Success in MTH 099, MTH 121, MTH 127, or MTH 130 by Entering Freshman Cohort

Characteristic	Enrolled Second Fall		Not Enrolled Second Fall	
	n	%	*n*	%
MTH 099 Basic Skills in Mathematics II				
Cohort 1 – Entered Fall 2010	37	84.1	7	15.9
Cohort 2 – Entered Fall 2011	39	80.0	10	20.0
Cohort 3 – Entered Fall 2012	44	77.2	13	22.8
Cohort 4 – Entered Fall 2013	41	82.0	9	18.0
Cohort 5 – Entered Fall 2014	28	87.5	4	12.5
MTH 121 Concepts and Applications				
Cohort 1 – Entered Fall 2010	29	90.6	3	9.4
Cohort 2 – Entered Fall 2011	39	95.1	2	4.9
Cohort 3 – Entered Fall 2012	45	90.0	5	10.0
Cohort 4 – Entered Fall 2013	46	88.5	6	11.5
Cohort 5 – Entered Fall 2014	20	74.1	7	25.9
MTH 127 College Algebra Expanded				
Cohort 1 – Entered Fall 2010	31	83.8	6	16.2
Cohort 2 – Entered Fall 2011	37	92.5	3	7.5
Cohort 3 – Entered Fall 2012	27	87.1	4	12.9
Cohort 4 – Entered Fall 2013	29	85.3	5	14.7
Cohort 5 – Entered Fall 2014	18	81.8	4	18.2
MTH 130 College Algebra				
Cohort 1 – Entered Fall 2010	17	89.5	2	10.5
Cohort 2 – Entered Fall 2011	18	90.0	2	10.0
Cohort 3 – Entered Fall 2012	23	85.2	4	14.8
Cohort 4 – Entered Fall 2013	12	80.0	3	20.0
Cohort 5 – Entered Fall 2014	11	68.8	5	31.2

n = 856

Further analyses were conducted to study the influence of the student attributes and high school performance measures on the retention outcomes. These data are organized by student attributes and high school performance measures.

Student Attribute Variables

A chi-square goodness of fit test was performed on each categorical independent variable. For the purposes of analysis, variables with cell sizes less than five were collapsed into two categories. Collapsed categories include ethnicity, father's educational level, and mother's educational level. For each variable, there are two tables reflecting the chi-square analyses.

The results of the chi-square analysis of sex and success in mathematics for fall-to-fall retention by freshman cohort are included in Tables C1 and C2 (see Appendix C). The analyses revealed no statistically significant differences based on sex in the retention outcomes.

The results of the chi-square analysis for ethnicity and success in mathematics for fall-to-fall retention by freshman cohort are presented in Tables C3 and C4 (see Appendix C). The analyses revealed no statistically significant differences based on ethnicity in the retention outcomes.

The results of the chi-square analysis for father's educational level and success in mathematics for fall-to-fall retention by freshman cohort are presented in Tables C5 and C6 (see Appendix C). The analysis reflected a significant difference in the retention outcomes for students in Cohort 3 who had successfully completed MTH 121 (p = .05). The retention rate was higher for students whose father's education level was high school or below (n = 32; 94.1%) than for students whose fathers had completed some college or beyond (n = 8; 72.7%). There were no other significant differences in the retention outcomes.

The results of the chi-square analysis for mother's educational level and success in mathematics for fall-to-fall retention by freshman cohort are reflected in Tables C7 and C8 (see Appendix C). The analysis reflected a significant difference in the retention outcomes for students in Cohort 4 who had successfully completed MTH 121 (p = .03). Students whose mothers had completed some college or beyond (n = 28; 96.6%) were retained at a higher rate than students whose mothers had completed high school or below (n = 16; 76.2%). The analysis also reflected a significant difference in the retention outcomes for students in Cohort 5 who had successfully completed MTH 130 (p = .05). The retention rate was higher for students whose mother's education level was college or beyond (n = 8; 88.9%) than for students whose mothers had completed high school or below (n = 2; 40%). There were no other significant differences based on the mother's education level and the retention outcomes.

The results of the chi-square analysis for Pell Grant eligibility and success in mathematics for fall-to-fall retention by freshman cohort are included Tables C9 and C10 (see Appendix C). The analysis reflected a significant difference in the retention outcomes for students in Cohort 3 who had successfully completed MTH 099 (p = .04). Students who were not eligible for Pell Grant (n = 20; 90.9%) were retained at a higher rate than students who were eligible for a Pell Grant (n = 23; 67.6%). There were no other significant differences in the retention outcomes.

An independent-samples t-test was used to compare each continuous independent variable with success in mathematics for fall-to-fall retention outcomes by freshman cohort. The t-test analysis for the estimated family contribution reflected a significant difference in the retention outcomes for students in Cohort 3 who had successfully completed MTH 130 (p = .00). Retained students had a significantly lower estimated family contribution (n = 23; M = 10,962, SD = 11,807) than students who were not retained (n = 4; M = 50,000, SD = 38,061). There were no other significant differences in the retention outcomes. Data from this analysis is presented in Table C11 (see Appendix C).

An independent-samples t-test analysis for unmet financial need reflected a significant difference in the retention outcomes for students in Cohort 1 who had successfully completed MTH 127 (p = .02). Unmet financial need was lower for students who were retained (n = 31; M = 1,080, SD = 2,653) than for students who were not retained (n = 6; M = 3,907, SD = 2,788). The analysis also identified a significant difference in the retention outcomes for students in Cohort 2 who had successfully completed MTH 127 (p = .05). The unmet financial need for this cohort was also found to be lower for students who were retained (n = 37; M = 252, SD = 3,797) than for students who were not retained (n = 3; M = 4,885, SD = 5,276). There were no other significant differences in the retention outcomes. Data from this analysis is presented in Table C12 (see Appendix C).

Student High School Performance Measures

Additional independent-samples t-tests were conducted on the high school performance measures. A t-test analysis for the overall high school GPA reflected a significant difference in the retention outcomes for students in Cohort 1 who had successfully completed MTH 127 (p = .05). Students who were retained (n = 31; M = 3.36, SD = .42) had a higher overall high school GPA than students who were not retained (n = 6; M = 2.96, SD = .49). A significant difference in the retention outcomes was also determined for students in Cohort 3 who had successfully completed MTH 127 (p = .04). Students in this cohort who were retained (n = 27; M = 3.58, SD = .33) also had a higher overall high school GPA than students who were not retained (n = 4; M = 3.18, SD = .44). In addition, the analysis reflected significance in the retention outcomes for students in Cohort 4 who had successfully completed MTH 130 (p = .03). Students who were retained (n = 12; M = 3.81, SD = .20) had a higher overall high school GPA than those who were not retained (*n* = 3; *M* = 3.39, *SD* = .48). There were no other significant differences in the retention outcomes. Data from this analysis is presented in Table C13 (see Appendix C).

An independent samples t-test analysis for the high school math GPA reflected a significant difference in the retention outcomes for students in Cohort 1 who had successfully completed MTH 099 (*p* = .02). The high school math GPA was higher (*n* = 36; *M* = 2.77, *SD* = .62) than for those who were not retained (*n* = 5; *M* = 2.07, *SD* = .60). The analysis also identified a significant difference in the retention outcomes for students in Cohort 1 who had successfully completed MTH 130 (*p* = .03). The high school math GPA was higher (*n* = 16; *M* = 3.60, *SD* = .54) than for those students who were not retained (*n* = 2; *M* = 2.63, *SD* = .18). There were no other significant differences in the retention outcomes. Data from this analysis is included in Table C14 (see Appendix C).

An independent samples t-test analysis for the highest ACT Mathematics score reflected a significant difference in the retention outcomes for students in Cohort 1 who had successfully completed MTH 121 (*p* = .05). Students who were retained had a lower ACT Mathematics score (*n* = 28; *M* = 18.71, *SD* = 2.44) than students who were not retained (*n* = 3; *M* = 21.67, *SD* = 1.53). There were no other significant differences in the retention outcomes. Data from this analysis is included in Table C15 (see Appendix C).

An independent samples t-test analysis for the highest SAT math score reflected no significant differences in the retention outcomes. Data from this analysis is included in Table C16 (see Appendix C).

An independent samples t-test analysis for the high school attendance percentage reflected a significant difference in the retention outcomes for students in Cohort 2 who had successfully completed MTH 099 (*p* = .05). Retained students had a higher high school attendance rate (*n* = 29; *M* = 94.5, *SD* = .05) than students who were not retained (*n* = 6; *M* = 90.0, *SD* = .07). There were no other significant differences in the retention outcomes. Data from this analysis is included in Table C17 (see Appendix C).

In summary, the chi-square goodness of fit analyses and the independent samples t-test analyses revealed some significant differences in the retention outcomes of students who had successfully completed MTH 099 (Basic Skills in Mathematics), MTH 121 (Concepts and Applications), MTH 127 (College Algebra Expanded), or MTH 130 (College Algebra). For students successful in MTH 099, there were significant differences in retention outcomes for Pell Grant eligibility (Cohort 3, $p = .04$), high school math GPA (Cohort 1, $p = .02$), and high school attendance percentage (Cohort 2, $p = .05$).

For students successful in MTH 121, there were significant differences in retention outcomes for father's educational level (Cohort 3, $p = .05$), mother's education level (Cohort 4, $p = .03$) and highest ACT Mathematics score (Cohort 1, $p = .05$). Significant differences in retention outcomes for students successful in MTH 127 were found for unmet financial need (Cohorts 1 and 2, $p = .02$ and $p = .05$, respectively) and overall high school GPA (Cohorts 1 and 3, $p = 05$ and $p = .04$, respectively). Significant differences in retention outcomes for students successful in MTH 130 were found for mother's educational level (Cohort 5, $p = .05$), estimated family contribution (Cohort 3, $p = .00$), overall high school GPA (Cohort 4, $p = .03$), and high school math GPA (Cohort 1, $p = .03$).

CHAPTER 5: CONCLUSIONS

Purpose of the Study

The purpose of this study was to evaluate multiple high school student attributes and performance measures that could be considered for use in predicting success in developmental mathematics courses and college-level math courses at Marshall University in Huntington, West Virginia. This study also evaluated the predictive ability of the same high school student attributes and performance measures in determining first-year fall-to-fall retention rates for successful math students.

In determining the predictive value of the student attributes and performance measures, higher education administrators can have a means in addition to state-mandated cut scores to evaluate students at risk of failure in mathematics and departure from the university. By identifying these at-risk students, there is an opportunity for postsecondary educators to implement recommendations or requirements for academic support programs and services (Laskey & Hetzel, 2011).

Maruyama (2012) conducted a study that resulted in a framework for assessing college readiness. This study was in part guided by Maruyama's work that recommended these guidelines:

> Assessments of college readiness should (a) use benchmarks with meaning and consequences for students, (b) employ multiple measures to provide readiness information more precise than from a threshold score derived from any single assessment, and (c) present readiness in terms of probabilities or likelihoods rather than as ready or not. (p. 252)

The specific research questions addressed in this study are:

1. Which high school measures and student attributes best predict performance in remedial math for graduates of West Virginia public high schools enrolling at Marshall University?
2. Which high school performance measures and student attributes best predict college readiness for math for graduates of West Virginia public high schools enrolling at Marshall University?
3. For students who succeed in remedial math, which high school performance measures and student attributes best predict success in college-level math for graduates of West Virginia public high schools enrolling at Marshall University?
4. Using college readiness in math as a filter, which high school performance measures and student attributes best predict first-year to second-year retention for graduates of West Virginia public high schools enrolling at Marshall University?

Population Sample

The population for this study included all entering first-time freshmen at Marshall University who entered in fall semesters 2010 through 2014 who graduated from a West Virginia public high school. The entry terms were determined based on the consistency of developmental and college-level math courses offered in those academic years. The number of entering first-time freshmen was 9,597. After eliminating non-resident students, West Virginia students who graduated from an out-of-state high school, students who graduated from private high schools, students with GED scores, home schooled students, students whose records reflected "unknown" high schools, and students who graduated from now defunct high schools, the resulting study population was 6,508 students.

The population was stratified based on each student's entering mathematics course. Based on the math course enrollment, a stratified random sample size was determined by using an online sample size calculator reflecting a 5% margin of error with a 95% confidence level. The resulting stratified random sample included 856 students.

Methods

In the first stage of the data collection, the sample student names and identification numbers were provided by the Marshall University Office of Institutional Research and Planning (MUIRP) to allow the manual collection of data from high school transcripts. The data collected included high school math course grades in order to calculate a high school math grade point average and the high school attendance percentage for the student's senior year of high school.

Once these data were collected, they were returned to the MUIRP to match with data in the university student database including sex, ethnicity, the father's level of education, the mother's level of education, Pell Grant eligibility, unmet financial need, estimated family contribution, the overall high school grade point average, the highest ACT Mathematics score reported to the case study institution, and the highest SAT Mathematics score reported to the case study institution. The math courses taken, the entering cohort year, and enrollment data were also collected. The complete data set was provided to the co-primary investigator with all identifying information redacted.

Several analyses were performed on the data set. Multiple chi-square goodness of fit tests were performed on the categorical independent variables which included sex, ethnicity, Pell Grant eligibility, father's educational level, and mother's educational level. For purpose of analysis, variables with cell sizes less than five were collapsed into two categories. Collapsed categories include ethnicity, father's educational level, and mother's educational level.

Independent samples t-tests and analyses of variance were performed on the continuous independent variables which included unmet need, estimated family contribution, overall high school GPA, high school math GPA, highest ACT Mathematics score, highest SAT Mathematics score, and high school attendance percentage. Tests were conducted in response to the identified research questions.

Findings

This study investigated the influence of twelve variables on the developmental and college entry level mathematics course outcomes and fall-to-fall retention at the case study institution. There were seven student attributes analyzed: sex, ethnicity, father's level of education, mother's level of education, Pell Grant eligibility, estimated financial contribution, and unmet financial need. In addition, there were five high school performance measures that were investigated: overall high school GPA, high school math GPA, highest ACT Mathematics score submitted to the case study institution, highest SAT Mathematics score submitted to the case study institution, and high school attendance percentage in the senior year. Each variable was investigated for each developmental and college entry-level course at the time of this study as well as fall-to-fall retention. The findings from this study are presented below and are organized by research question.

Students who successfully completed MTH 098 were less likely than those who were not successful to be eligible for a Pell Grant, had higher estimated family contributions, and had lower unmet need indicating a higher socioeconomic status. Further analyses revealed that students with higher overall GPAs and higher high school math GPAs were more likely to be successful in MTH 098. There were no other significant influences on the course outcomes for MTH 098. Students who successfully completed MTH 099 were more likely than those who were not successful to be white, have a lower unmet financial need, and have higher GPAs, higher math GPAs, and higher ACT Mathematics scores. There were no other significant influences on the course outcomes for MTH 099. Students successful in MTH 099 after successfully completing MTH 098 were more likely than those who were not successful in MTH 099 to be white than black, have higher overall high school GPAs, have higher high school math GPAs, and higher ACT Mathematics scores.

Students who received grades of A in MTH 121 were less likely than students receiving a D, F, or W to be eligible for a Pell Grant. Unmet financial need was higher and estimated family contribution was lower for students receiving grades of D, F, or W than for students receiving a grade of A, B, or C. The overall high school GPA was highest for those students who received a grade of A in MTH 121 and progressively decreased for grades of B, C, or D, F, or W. The high school math GPA was highest for students who received a grade of A and progressively decreased for grades of B and C, but took a slight increase for a grade of D, F, or W. The ACT Mathematics score and high school attendance percentage was highest for those students who received a grade of A and progressively decreased through grades of B, C, and D, F, or W.

Female students were more likely to receive grades of A or B, while males were more likely to receive grades of C, D, F, or W in MTH 127. Overall high school GPA was greater for students who received As in MTH 127 and the GPA progressively decreased for students with lower course grades. The high school math GPA and the highest ACT Mathematics score were both highest for those students who received an A in MTH 127, decreased for a grade of B, then increased slightly from the B to a C, and then decreased again for grades of D, F, or W. The high school attendance percentage was highest for students who received a grade of A and decreased progressively.

Students whose mothers attended college or beyond were more likely to succeed with a grade of A, B, or C and were much less likely to receive a grade of D, F, or W in MTH 130. Students who received grades of A or B had lower unmet need than students who received grades of C, D, F, or W. The overall high school GPA, the high school math GPA, and the highest ACT Mathematics score were highest for students receiving grades of A in MTH 130.

Students can be directly placed in MTH 121, MTH 127, and MTH 130; however, students not eligible for direct entry can gain entry to MTH 121 or MTH 127 via completion of MTH 099. For Research Question 3, further analyses were conducted to determine whether any of the twelve variables significantly influenced course outcomes in MTH 121 or MTH 127 for students who first succeeded in MTH 099. MTH 130 was not investigated for this research question because students enter the course on direct entry only (see findings for Research Question 2).

Students who received a grade of A in MTH 121 were more likely to have a higher GPA than those students receiving grades of B, C, or D, F. or W. Students who received a grade of A in MTH 127 were more likely to have a higher overall high school GPA than those receiving grades of B, C, or D, F. or W. Students who received a grade of A in MTH 127 were also more likely to have a higher high school math GPA than those receiving grades of B, or D, F, or, W.

College readiness was defined as student success in either MTH 099 (Basic Skills in Mathematics II), MTH 121 (Concepts and Applications), MTH 127 (College Algebra Expanded), or MTH 130 (College Algebra). Once success in a math course was determined, enrollment data for the second fall semester after the cohort entered the case study institution were collected. The fall-to-fall retention rate for successful students across all cohorts in the study ranged from a low of 68.8 percent to a high of 95.1 percent. The retention rate for unsuccessful students ranged from a low of 4.9 percent to a high of 31.2 percent.

Students successfully completing MTH 121 in Cohort 3 whose father's educational level was reported as high school or below were retained at a higher rate than those who reported the father's educational level as college or beyond. Students successfully completing MTH 121 in Cohort 4 and MTH 130 in Cohort 5 and whose mother had completed some college or beyond were retained at a higher rate that students whose mothers had completed high school or below.

Students successfully completing MTH 099 in Cohort 3 who were not eligible to receive a Pell Grant were retained at a higher rate than those students who were Pell Grant eligible. Unmet need was found to significantly influence retention outcomes for MTH 127 in Cohort 1 and Cohort 2. The unmet need for students successfully completing MTH 127 in Cohort 1 and 2 was lower for students who were retained than for students not retained in both cohorts.

The overall high school GPA was higher for student success in MTH 127 who were retained than those who were not retained in Cohorts 1 and 3 and for student success in MTH 130 in Cohort 4. The high school math GPA was found to significantly influence retention outcomes for MTH 099 and MTH 130 in Cohort 1. The high school math GPA was higher for those students in Cohort 1 who were successful in MTH 099 and MTH 130 and were retained than those students who were not retained.

The highest ACT Mathematics score was found to significantly influence retention outcomes for MTH 121 in Cohort 1. The highest ACT Mathematics score for students successfully completing MTH 121 in Cohort 1 was lower for students who were retained than for students who were not retained. The high school attendance percentage was found to significantly influence retention outcomes for students successful in MTH 099 in Cohort 2. The high school attendance percentage for students who successfully completed MTH 099 in Cohort 2 was higher for students who were retained than for those students who were not retained.

There were no significant influences on retention outcomes in any cohort based on sex, ethnicity, or highest SAT Mathematics score.

Conclusions

The data collected and analyses conducted during this study support the following conclusions for each research question.

Research Question 1: Which high school measures and student attributes best predict performance in remedial math for graduates of West Virginia public high schools enrolling at Marshall University?

Pell grant eligibility, estimated family contribution, unmet financial need, ethnicity, overall high school GPA, ACT Mathematics, and high school math GPA are student attributes and high school performance measures that best predict performance in remedial math courses (MTH 098 and MTH 099) at Marshall University. Students who successfully completed MTH 098 were less likely to be eligible for a Pell grant, have higher estimated family contributions, have lower unmet financial need, have higher overall high school GPAs, and have higher high math GPAs than those students who were not successful in the course. Students who successfully completed MTH 099 were more likely than those who did not to be white rather than black, have lower unmet financial need, have higher overall high school GPAs, have higher high school math GPAs, and have higher ACT Mathematics scores. Students who successfully completed MTH 099 after completing MTH 098 were more likely to be white rather than black, have higher overall high school GPAs, have higher high school math GPAs, and have higher ACT Mathematics scores. Overall high school GPAs and high school math GPAs are the most consistent predictors of success in remedial math courses with ethnicity, unmet financial need, and ACT Mathematics scores providing a lesser level of predictive consistency.

Research Question 2: Which high school performance measures and student attributes best predict college readiness for math for graduates of West Virginia public high schools enrolling at Marshall University?

Pell grant eligibility, estimated family contribution, unmet financial need, sex, mother's educational level, overall high school GPA, ACT Mathematics, high school math GPA, and high school attendance percentage are student attributes and high school performance measures that predict performance in college-level math courses (MTH 121, MTH 121, and MTH 130) at Marshall University. Students who successfully completed MTH 121 were less likely than those who were not successful to be eligible for a Pell Grant, have higher estimated family contributions, have lower unmet financial need, have higher overall high school GPAs, have higher high school math GPAs, have higher ACT Mathematics scores, and a higher high school attendance percentage. Students who were successful in MTH 127 were more likely to be female, have higher overall high school GPAs, have higher high school math GPAs, have higher ACT Mathematics scores, and have higher high school attendance percentages. Students who were successful in MTH 130 were more likely to have mothers with some college education or beyond, have a lower unmet financial need, have higher overall high school GPAs, have higher high school math GPAs, and have higher ACT Mathematics scores. Overall high school GPAs, high school math GPAs, and ACT Mathematics scores are the most consistent predictors of success in college-level courses with unmet financial need and high school attendance percentages providing a lesser level of predictive consistency.

Research Question 3: For students who succeed in remedial math, which high school performance measures and student attributes best predict success in college-level math for graduates of West Virginia public high schools enrolling at Marshall University?

Overall high school GPA and high school math GPA are the high school performance measures that best predict performance in college-level math courses (MTH 121 and MTH 127) after first completing MTH 099 at Marshall University. Students who were successful in MTH 121 after first completing MTH 099 have higher overall high school GPAs. Students who were successful in MTH 127 after first completing MTH 099 have higher overall high school GPAs and higher high school math GPAs. The overall high school GPA was the most consistent predictor of success in college-level math courses after completing remediation.

Research Question 4: Using college readiness in math as a filter, which high school performance measures and student attributes best predict first-year to second-year retention for graduates of West Virginia public high schools enrolling at Marshall University?

Father's educational level, mother's educational level, Pell Grant eligibility, estimated family contribution, unmet financial need, overall high school GPA, high school math GPA, ACT Mathematics score, and high school attendance percentage are student attributes and high school performance measures that reflected a minimal level of influence in predicting fall-to-fall retention when using college readiness in math as a filter. These findings notwithstanding, no single student attribute or performance measure produced results sufficiently consistent to be a consistent predictor of first year to second year retention.

Discussion and Implications

None of the seven student attributes or five high school performance measures analyzed in this study can be directly controlled by the higher education institution; however, higher education administrators can use the results of this study and similar studies to inform developmental education policies and practices at the institutional level. Results from this study could be used to identify specific student attribute and high school performance variables for development of a profile of a student unlikely to succeed in a particular math course at the institution. Administrators in collaboration with the mathematics department could then take action in identifying students aligning with this profile and recommend or require supplemental support intended to promote mathematics success.

It is becoming more common that high school graduates are not meeting grade-level competencies (Long and Riley, 2007). Lack of preparation often leads to placement in remedial course work which can result in a major barrier to college persistence. Moore (2004) believed that underprepared students could "catch up" (p. 32) and Tinto (1999) held that underprepared students could surpass their better prepared classmates if given appropriate supports. Giuliano & Sullivan (2007) suggested that one of the most challenging tasks for educators is convincing underprepared students that they can succeed; however, success requires motivation and support. Unlike the students who are prepared for college, the underprepared students are less likely to recognize when they are struggling and when they need to seek help (Conley, 2007a). Laskey & Hetzel (2011) suggested that colleges must help these students recognize when they are faltering and provide resources for help.

Integrating the support into the remedial classroom is one way to encourage participation. Boylan (2011) recommended that developmental mathematics instructors integrate teaching methods that incorporate frequent practice exercises and quizzes, mathematics vocabulary, web-based support where appropriate and available, group work, and tutoring based on individual student learning styles. He further recommended the support of counselors in the classroom to address anxiety issues thus opening the door for referrals for other more complex personal problems.

In 2009 in a joint session of the U.S. Congress, President Barack Obama declared that the U.S. in the year 2020 would once again have the largest proportion of college graduates in the world (Obama, 2009). He acknowledged that an educated population was necessary to be competitive in a global economy and he challenged students to enroll in community colleges, four-year colleges, vocational schools, and career training schools. In a report by TG (2014), *Developmental Education and Student Debt: Remediation's Uncertain Impact on Financial and Academic Outcomes*, Fernandez, Barone, and Klepfer suggested that one way to reach Obama's goal was to encourage more underprepared students to enroll in postsecondary education; however, they also emphasized the importance of providing remedial pathways that ensure success for these students. While it is important to provide access and opportunity to students with a broad range of abilities, Engstrom and Tinto (2008) proposed that "Access without support is not opportunity" (p. 50).

Colleges and universities without selective admissions policies are already admitting large numbers of students who are not prepared for college. Students can be admitted by meeting the minimum high school grade point average and standardized test composite scores, but fail to meet to the college-level benchmarks for reading or mathematics. College admission is a commitment to a student; once a college or university offers admission to a student, the administration is then obligated to provide the support system necessary for that student to succeed, but it is also the student's responsibility to take advantage of the provided support.

Conley (2007a) defined success as "… completing entry-level courses at a level of understanding and proficiency that makes it possible for the student to consider taking the next course in the sequence or the next level of course in the subject area." (p. 5). This study utilized success in math as a filter for analyzing fall-to-fall retention. Retention rates for successful math students were found to be generally higher than the University's overall fall-to-fall retention rates. Fall-to-fall retention for successful math students in the study sample population ranged from a low of 68.8 percent to a high of 95.1 percent while the retention rate for unsuccessful students ranged from a low of 4.9 percent to a high of 31.2 percent. Based on Marshall University's Common Data Sets for the five years identified in this study, the University's fall-to-fall retention rate ranged from a low of 69% for Fall 2013 (Cohort 3) to a high of 73% in Fall 2014 (Cohort 4) and Fall 2015 (Cohort 5); the rate for Fall 2011 (Cohort 1) was 70% and the rate for Fall 2012 (Cohort 2) was 71%; (Marshall University Common Data Set, 2012, p. 5; Marshall University Common Data Set, 2013, p. 3; Marshall University Common Data Set, 2014, p. 5; Marshall University Common Data Set, 2015, p. 5; Marshall University Common Data Set, 2016, p. 5). According to the most recent College Score Card posted by the U.S. Department of Education, the national fall-to-fall retention rate is 68% (College Score Card, 2016). The lowest retention rate represented in this study exceeded that national average by nearly one percent. One could surmise that success in math is one of the keys to retention in general and should confirm the importance of providing multiple opportunities for students to succeed in math whether through required support programs, supplemental instruction, required tutoring, or other academic support options.

In determining the students at risk, higher education administrators need to know what factors influence likelihood to depart from the university. In this study, there were 240 analyses completed to determine whether or not a student attribute or high school performance measure in combination with math course success and a particular cohort significantly influenced retention outcomes. Of the 240 analyses, there were 14 instances where a variable was found to have a significant influence; however, those influences were spread across most variables and none were consistent among math courses or cohorts. The same is true of another 13 analyses that approached significance. The most common variables achieving or approaching significance were overall high school GPA and high school math GPA, but those, too, were not consistent. This suggests that there is no particular variable that influences retention or departure once the student has successfully completed a math course. Higher education administrators should consider efforts that directly promote success in math which, in turn, might also lead to increased fall-to-fall retention.

In West Virginia, cut scores for entry into developmental and college-level mathematics courses have traditionally been based on the standardized ACT Mathematics score or the equivalent standardized SAT Mathematics score. In a report entitled *Core Principles for Transforming Remedial Education: A Joint Statement,* the Charles A. Dana Center, Complete College America, Inc., the Education Commission for the States and Jobs for the Future (2012) stated that "…the evidence of the predictive validity of these tests is not as strong as many might assume, and research fails to find evidence that the resulting placements into remediation improve student outcomes" (p. 3). Higher education administrators could utilize data from this study and similar studies to lobby for change in state-level policy regarding the sole use of standardized cut-scores for math course placement.

In this study, each of the 12 student attributes and high school performance variables were evaluated independently. The highest ACT Mathematics score variable was found to be influential in multiple course performance outcomes; however, in each case where it was found to significantly influence course outcomes, there were other variables significantly influencing those same outcomes. In every instance the highest ACT Mathematics score was found to be significant, the overall high school GPA and the high school math GPA were also found to be significant suggesting that these variables might work together in influencing outcomes. Based on the results of this study, recommendations for specific overall high school GPA and/or high school math GPA should be evaluated for use in combination with standardized cut scores to develop a standardized formula for mathematics course placement.

Kurlaender and Howell (2012) reported that there is no single factor that is an effective predictor of college success. Maruyama (2012) stated that "…choosing thresholds based on single assessments are problematic…Incorporating multiple measures to determine readiness should increase the accuracy of judgments about readiness" (p. 259). Maruyama further suggested that utilizing multiple measures in assessing readiness would be more precise than developing a threshold based on an individual measure. Atkinson and Geiser (2009) theorized that the overall high school GPA is likely the best predictor of college success, so the findings from this study suggest that implementation of a placement formula utilizing a standardized test score in combination with an overall high school GPA and/or the high school math GPA would be appropriate.

Maruyama (2012) not only suggested that multiple measures be employed for determining college readiness, he also recommended that administrators should "…as much as possible use information already being collected…to minimize burden on schools and students" (p. 259). The overall high school GPA is one of those measures already collected and readily available for use in a college-readiness formula; however, the high school math GPA is not readily available. In some cases, it may not be possible to use the high school math GPA unless institutional level procedures are changed. At the case study institution and possibly other institutions, individual high school math grades are not entered into the student database from the high school transcript nor is the transcript scanned and attached to the student's electronic records. Therefore, a high school math GPA could not be used in any electronic calculations for placement, it could not be used as an electronic pre-requisite for course enrollment, nor would it be accessible to academic advisors for manual calculation for course placements. For this reason, an institutional procedure change would be necessary to incorporate use of the high school math GPA as part of a multidimensional formula for determining math placement. Such a procedure change would likely require additional staff in admissions or records offices.

The AASCU (2008) recommended that the fundamental causes for remediation to be addressed. "Rather, the underlying causes of remediation need to be addressed so that increasing numbers of students enter postsecondary education ready for college-level work" (AASCU, 2008, p. 8). While "public high schools are doing a good job of preparing many graduates, they are seriously failing a substantial minority" (Achieve, Inc., 2005, p. 2). Conley (2007b) further surmised that the high school learning experience "has been reduced to a form of sleepwalking, requiring no deep mastery of understanding" (p. 23). Perhaps the most important challenge is resolving the problem that leaves graduated high school students unprepared for college and the work force.

Maruyama (2012) recommended employing the "…engagement of constituent groups to collectively determine what college readiness means and how it is determined should occur, which should result in broader thresholds better aligned with actual success rates" (p. 259). Collaborations between K-12 and higher education can use the results of this study or similar studies to evaluate their student populations based on applicable student profiles for success and failure. Kurlaender and Howell (2012) reported that the single best predictor of college success is the "…accumulation of academic skills and preparation in high school" (p. 4). Rather than waiting for college to remediate and provide educational support systems, secondary institutions can utilize the results of this study and similar studies to implement support systems for those students who meet the profile of an at-risk, underprepared students. Students meeting a profile for the likelihood to be successful should not be ignored; those students should continue to receive motivational support and encouragement to further increase their likelihood of success. Conley (2007b) proposed strategies to minimize the gap in the alignment of the high school curriculum with postsecondary expectations by comparing course content and developing an academic focus on the last two years of high school; implementation of high quality syllabi in all high school courses similar to those used in college; the implementation of senior seminars to replicate what students should expect in college; and reintroducing the missing high school content such as vocabulary, historical themes, strategic reading, problem-solving, the scientific method, and more.

ACT released a report in 2016 called *The Condition of College and Career Readiness.* The report shows that 67% of 2016 West Virginia high school graduates took the ACT exam. Thirty-two percent of those students met the college-readiness benchmark for math. The number of students failing to meet this benchmark presents a grave challenge for our postsecondary institutions in the state. In the 2016 Kids Count Data Book, the Annie E. Casey Foundation reports that:

> Competence in mathematics is essential for success in the workplace, which increasingly requires higher-level technical skills. Students who take advanced math and science courses are more likely to graduate from high school, attend and complete college and

> earn higher incomes…Ensuring that children have early access to high-quality mathematics education is critical for their success in both school and life. (p. 27).

ACT recommends "…investment in postsecondary teaching programs, professional development, and state-level collaboration among K-12 and higher education" (2016, p. 17) in order to improve the quality of teaching in the high schools which is identified as critical to increasing college readiness.

Addressing remedial education on multiple fronts is a pressing need. Failure to graduate underprepared students results in significant burdens on educational institutions and our communities. Higher education administrators need to implement studies similar to this study to evaluate the student profiles for their specific student populations and work to assist and support success for at-risk students. There needs to be supports evaluated and provided at the institutional and departmental levels to affect change in the remedial classroom and promote a higher rate of success and retention for all student profiles. As this study determined, it appears that success in math leads to higher rates of retention. We make a commitment to these students upon their admission; therefore, we are obligated to provide opportunity for students to meet the challenge of college persistence.

Colleges and university administrators must promote change for state-level policies involving course placement. Studies similar to this case-study should be conducted at the state-wide level for each institution type from vocational training, to career and technical colleges, and four-year colleges and universities. In addition to the standardized cut-scores, an additional measure or measures should be considered in determining placements levels.

Perhaps most importantly, this study and similar studies should provide a foundation for developing collaborations between K-12 and postsecondary education to reconstruct college readiness strategies at the secondary level. The Alliance for Excellent Education (2011) reported that the need for remediation is costly and should not be considered a substitute for an adequate high school education. In *Out of Pocket: The High Cost of Inadequate High Schools and High School Student Achievement on College Affordability*, a document published by Education Reform Now (2016), Barry and Dannenberg report that “Hundreds of thousands of American families across all income levels are spending billions each year in extra college costs because our high schools are graduating too many students unprepared for college” (p. 2)” According to Barry and Dannenberg (2016), this represents an “expansive failure of our K-12 education system” (p. 2). For the student, the impact caused by the lack of success and retention includes the cost of additional courses, high failure rates, and the loss of lifetime wages when they do not succeed. But the repercussions extend far beyond the impact on the individual student. The report stated:

> Not only is remediation an ineffective solution to the preparation gap problem, it is also a wasteful use of public and private dollars. Helping students catch up to the expectations of postsecondary work affects the nation’s overall economic strength and involves significant costs for taxpayers, postsecondary institutions, and students. (Alliance for Excellent Education, 2011, p. 4)

According to Barry and Dannenberg (2016), the cost of preparing students for college has shifted from K-12 to postsecondary education where “students and families are left to assume an unnecessary financial burden that can have damaging consequences – including long-term opportunity costs” (p. 10).

When students are not prepared for college and the appropriate academic supports are not provided, colleges and universities reap the consequences of lower retention rates, lower graduation rates, and increased student loan default rates. In today's society where institutions can be easily compared via vehicles such as the College Scorecard, these consequences create questions about the quality and value of the educational experience.

Recommendations for Future Research

This study presented a broad analysis of seven student attributes and five high school performance measures and their potential for predicting success in remedial and college-level math courses as well as first-year, fall-to-fall retention at the case study institution. Each variable was analyzed independently for significance in influencing course and retention outcomes. This study could be enhanced by concurrently analyzing multiple variables for significance toward the same outcomes. For example, the three variables reflecting socioeconomic status (Pell Grant eligibility, unmet financial, need, and estimated family contribution) could be analyzed concurrently for significance in course performance and retention outcomes. Tests could be performed using overall high school GPA and highest ACT Mathematics score to determine an appropriate formula for success in course placement. In addition, this study could be further enhanced by expanding the analyses to include a measurement of performance outcomes in all mathematics courses offered at the case study institution that have direct entry on the basis of a standardized test cut score.

A qualitative component to this study would also enhance the results. Interviewing developmental math faculty would identify insight into the reasons that students are succeeding or not succeeding in their courses. Faculty could be interviewed in regard to their opinion of students' abilities when they enter the course, the learning patterns that students display in the classroom, and the amount of effort applied to learning new concepts. Developmental students could also be interviewed about their own perceptions of their personal level of college preparedness in math, the amount of effort put forth in the classroom and on assignments while in high school, and the amount and source(s) of encouragement received while in high school. The qualitative results could be used as a springboard for discussion in collaborative meetings with secondary and postsecondary representatives.

REFERENCES

Achieve, Inc. (2005). *Rising to the challenge: Are high school graduates prepared for college and work?* Washington, DC: Author not listed.

Adelman, C. (1996). The truth about remedial work (Point of view). *The Chronicle of Higher Education,* A56.

Adelman, C. (1998). The kiss of death? An alternative view of college remediation. *National Crosstalk,* 6(3), 11.

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school to college.* Washington, DC: U.S. Department of Education.

Alliance for Excellent Education. (2011). *Saving now and saving later: How high school reform can reduce the nation's wasted remediation dollars.* Washington, DC: Author not listed.

American Association of State Colleges and Universities. (2008). *Enhancing college student success through developmental education*. Washington, DC: Russell, A.

American Association of State Colleges and Universities. (2014). *Top 10 higher education state policy issues for 2014.* Washington, DC: Hurley, D. J., Harnisch, T. L., & Parker, E. A.

American Association of State Colleges and Universities. (2015). *Top 10 higher education state policy issues for 2015.* Washington, DC: Hurley, D. J., Harnisch, T. L., & Parker, E. A.

American College Testing (ACT) Research Report Series 2004-4. (2004). *High school grade inflation from 1991 to 2003.* Iowa City, IA: Woodruff, D. J., & Ziomek, R. L.

American College Testing (ACT). (2007). *Rigor at risk: Reaffirming quality in the high school core curriculum.* Iowa City, IA. Author not listed.

American College Testing (ACT). (2016). *The Condition of College & Career Readiness.* Iowa City, IA. Author not listed.

American College Testing (ACT) and the Council for Opportunity in Education (COE). (2015). *The condition of college & career readiness 2014: First generation students.* Iowa City, IA: Author not listed.

American College Testing (ACT) and the National Center for Educational Achievement (NCEA). (2009). *Preparation Matters.* Iowa City, IA: Author not listed.

American College Testing (ACT) Research and Policy. (2013). *What are the ACT college readiness benchmarks?* Iowa City, IA: Author not listed.

Annie E. Casey Foundation. (2016). *Kids Count Data Book*. Baltimore, MD: Author not listed.

Arendale, D. (2005). Terms of endearment: Words that define and guide developmental education. *Journal of College Reading and Learning*, 35(2), 66-82.

Astin, A. W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development,* 40(5), 518-529.

Astin, A. W. (2000). The civic challenge of educating the underprepared student. In T. Ehrlich (Ed.), *Civic responsibility in higher education* (pp. 124-146). Phoenix, AZ: Oryx Press.

Atkinson, R. C., & Geiser, S. (2009). Reflections on a century of college admissions tests. *Educational Researcher, 38,* 665-676.

Attewell, P., Lavin, D., Domina, T., & Levey, T. (2006). New evidence on college remediation. *The Journal of Higher Education, 77, 886-924.*

Bailey, T. (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. *New Directions for Community Colleges,* 145, 11-30.

Bettinger, E. P., & Long, B. T. (2005). Remediation at the community college: Student participation and outcomes. *New Directions for Community Colleges,* 129, 17-26.

Bettinger, E. P., & Long, B. T. (2008). Shape up or ship out: The effect of remediation on underprepared students at four-year colleges. *Journal of Human Resources,* 44(3), 736-771.

Boylan, H. R. (2009). Targeted intervention for developmental education students (T.I.D.E.S.). *Journal of Developmental Education, 32*(3), 14-23.

Boylan, H. R. (2011). Improving success in developmental mathematics: An interview with Paul Nolting. *Journal of Developmental Education,* 34(3), 20-27.

Charles A. Dana Center, Complete College America, Inc., Education Commission for the States, & Jobs for the Future. (2012). *Core principles for transforming remedial education: A joint statement.* Author not listed.

College Score Card. (2016). Washington, D. C.: U.S. Department of Education. Retrieved from https://collegescorecard.ed.gov/

Conley, D. T. (2007a). *Redefining college readiness*. Eugene, OR: Educational Policy Improvement Center.

Conley, D. T. (2007b). The challenge of college readiness. *Educational Leadership,* 64(7), 23-29.

Education Commission of the States. (2014a). *A cure for remedial reporting chaos: Why the U.S. needs a standard method for measuring preparedness for the first year of college.* Denver, CO: Author not listed.

Education Reform Now (ERN). (2016). *Out of Pocket: The High Cost of Inadequate High Schools and High School Student Achievement on College Affordability.* Washington, DC: Barry, M. N., and Dannenberg, M.

Engstrom, C. & Tinto, V. (2008). Access without support is not opportunity. *Change, 46-50.*

Gallard, A. J., Albritton, F., & Morgan, M. W. (2010). A comprehensive cost/benefit model: Developmental student success impact. *Journal of Developmental Education,* 34(1), 10-25.

Giuliano, B., & Sullivan, J. (2007). Academic wholism: Bridging the gap between high school and college. *American Secondary Education,* 35(3), 7-18.

Gerring, J. (2004). What is a case study and what is it good for? *American Political Science Review, 98*(2), 341-354.

Howell, J. S. (2011). What influences students' need for remediation in college? Evidence from California. *The Journal of Higher Education,* 82(3), 292-318.

Kern, C. W., Fagley, N. S., & Miller, P. M. (1998). Correlates of college retention and GPA: Learning and study strategies, testwiseness, attitudes, and ACT. *Journal of College Counseling,* 1, 26-34.

Kuh, G. D. (2007). What student engagement data tell us about college readiness. *Association of American Colleges & Universities Peer Review,* 9(1). Retrieved from: https://www.aacu.org/publications-research/periodicals/what-student-engagement-data-tell-us-about-college-readiness

Kurlaender, M. & Howell, J. S. (2012). Collegiate remediation: A review of the causes and consequences. *College Board Advocacy & Policy Center, 1-13.*

Laskey, M. L., & Hetzel, C. J. (2011). Investigating factors related to retention of at-risk college students. *The Learning Assistance Review*, 16(1), 31-43.

Long, B. T., & Riley, E. (2007). Financial aid: A broken bridge to college access? *Harvard Educational Review*, 77(1), 39-63.

Long, M., Iatarola, P., & Conger, D. (2009). Explaining gaps in readiness for college-level math: The role of high school courses. *American Education Finance Association*, 1-33.

Marshall University Common Data Set 2011-2012. (2012). Huntington, WV: Marshall University. Retrieved from *http://www.marshall.edu/irp/CDS2011_2012_mu.pdf*

Marshall University Common Data Set 2012-2013. (2013). Huntington, WV: Marshall University. Retrieved from *http://www.marshall.edu/irp/CDS_2012_2013_mu.pdf*

Marshall University Common Data Set 2013-2014 (2014). Huntington, WV: Marshall University. Retrieved from *http://www.marshall.edu/irp/CDS_2013_2014_mu.pdf*

Marshall University Common Data Set 2014-2015 (2015). Huntington, WV: Marshall University. Retrieved from *http://www.marshall.edu/irp/CDS2014_2015_mu.pdf*

Marshall University Common Data Set 2015-2016 (2016). Huntington, WV: Marshall University. Retrieved from *http://www.marshall.edu/irp/CDS_2015-2016_mu.pdf*

Marshall University Databook. (2013). Huntington, WV: Marshall University. Retrieved from http://www.marshall.edu/irp/Databook/databook2013.pdf

Marshall University Undergraduate Catalog 2010-2011. (2010). Huntington, WV: Marshall University. Retrieved from http://www.marshall.edu/catalog/files/2013/01/ug_10-11_published.pdf

Marshall University Undergraduate Catalog 2011-2012. (2011). Huntington, WV: Marshall University. Retrieved from http://www.marshall.edu/catalog/files/2013/01/ug_11-12_published.pdf

Marshall University Undergraduate Catalog 2012-2013. (2012). Huntington, WV: Marshall University. Retrieved from http://www.marshall.edu/catalog/files/2013/01/UG_12-13_published.pdf

Marshall University Undergraduate Catalog 2013-2014. (2013). Huntington, WV: Marshall University. Retrieved from http://www.marshall.edu/catalog/files/2013/10/UG_13-14_published_rev10-29-13.pdf

Marshall University Undergraduate Catalog 2014-2015. (2014). Huntington, WV: Marshall University. Retrieved from http://www.marshall.edu/ucomm/files/web/UG_14-15_published.pdf

Maruyama, G. (2012). Assessing college readiness: Should we be satisfied with ACT or other threshold scores? *Educational Researcher*, 41(7), 252-261.

McCormick, N. & Lucas, M. (2011). Exploring mathematics college readiness in the United States. *Current Issues in Education,* 14(1). Retrieved from http://cie.asu.edu/ojs/index.php/cieatasu/article/view/680

Moore, R. (2004). Do colleges identify or develop intelligence? *Journal of Developmental Education,* 28(1), 28-34.

Moore, G. W., Slate, J. R., Edmonson, S. L., Combs, J. P., Bustamante, R., & Onwuegbuzie, A. (2010). High school students and their lack of preparedness for college: A statewide study. *Education and Urban Society*, 42(7), 817-838.

National Center for Education Statistics. (2003). *Remedial education at degree-granting postsecondary institutions in fall 2000.* Washington, DC: Parsad, B., Lewis, L., & Greene, B.

National Center for Education Statistics. (2013). *First-year undergraduate remedial coursetaking: 1999-2000, 2003-04, 2007-08.* Washington, DC: Sparks, D. and Malkus, N.

Obama, B. H. (2009). *Remarks of President Barack Obama—As prepared for delivery: Address to joint session of Congress*. Retrieved from: http://www.whitehouse.gov/the_press_office/Remarks-of-President-Barack-Obama-Address-to-Joint-Session-of-Congress

Perna, L. W., & Armijo, M. (2014). The persistence of unaligned K-12 and higher education systems. Why have statewide alignment efforts been ineffective? *Annals of the American Academy of Political and Social Science,* 655, 16-35.

Schneider, B., Swanson, C. B., & Riegle-Crumb, C. (1998). Opportunities for learning: Course sequences and positional advantages. *Social Psychology of Education*. 2:25-53.

Scott-Clayton, J., & Rodriguez, O. (2015). Development, discouragement, or diversion? New evidence on the effects of college remediation policy. *Education Finance and Policy,* 10(1), 4 – 45.

Southern Region Education Board. (2010). *Promoting a culture of student success*. Atlanta, GA: Bradley, Jr., A. P., & Blanco, C. D.

Southern Region Education Board. (2010). *Beyond the rhetoric: Improving college readiness through coherent state policy.* Atlanta, GA: Author not listed.

Strong American Schools [SAS]. (2008). *Diploma to nowhere*. Washington, DC: Author not listed.

TG. (2014). *Developmental Education and Student Debt: Remediation's Uncertain Impact on Financial and Academic Outcomes.* Round Rock, TX: Fernandez, C., Barone, S., and Klepfer, K.

The Pell Institute for the Study of Opportunity in Higher Education. (2013). *Provisional admission practices: Blending access and support to facilitate student success*. Washington, DC: Nichols, A. H., & Clinedinst, M.

Tierney, W. G. (2004). Academic triage: Challenges confronting college preparation programs. *Qualitative Inquiry*, 10(6), 950-962.

Tinto, V. (1988). Stages of student departure: Reflections on the longitudinal character of student leaving. *The Journal of Higher Education*, 59(4), 438-455.

Tinto, V. (1999). Taking student retention seriously: Rethinking the first year of college. *National Academic Advising Association Journal*, 19(2), 5-9.

West Virginia Higher Education Policy Commission. (2010). *Freshman assessment and placement standards.* (WVHEPC Title 133 Series 21). Charleston, WV.

Yin, R. K. (2014). *Case Study Research: Design and Methods* (5th ed.). Thousand Oaks, CA: Sage Publications, Inc.

APPENDIX A: Permission for University Data

Stepp, Sherri

From:	Ormiston, Gayle
Sent:	Monday, November 9, 2015 4:16 PM
To:	Stepp, Sherri
Cc:	McGuffey, Michael; Smith, Sherri; Smith, Michael
Subject:	Re: Follow-up to dissertation research request

11.07.15

Sherri,

After due consideration and review, I hereby approve your request.

Gayle

Gayle L. Ormiston
Provost and Senior Vice President for Academic Affairs
Marshall University

From: <Stepp>, Sherri <goodall@marshall.edu>
Date: Saturday, August 15, 2015 at 3:01 PM
To: Gayle Ormiston <ormiston@marshall.edu>
Cc: Michael McGuffey <mcguffey@marshall.edu>, Sherri Smith <smithsc@marshall.edu>
Subject: Follow-up to dissertation research request

Gayle
In follow up to my request for some initial data for dissertation research planning, I have decided that I should explain the proposed research project in greater detail. I have attached a diagram explaining expected data needs as well as the defined independent and dependent variables.

- *From the designated fall semesters (Fall 2010 – Fall 2014), I would need a sample of student names and ID numbers with no data attached.*
- *I would then take these names and numbers and manually review high school transcripts and collect data (see diagram).*
- *The data would be stored in a spreadsheet format. I would relinquish all copies of that data to an IR representative.*
- *With permission, the IR representative would match University data (some demographic data, math performance, and retention data) on those same students.*
- *The high school and University data would be returned to me completely de-identified for my analysis.*

On one hand, I understand the concern about blurring the lines between being a student and a staff member. On the other hand, I am both. I am interested in the results of this research because I work daily with at-risk students who are underprepared. I am hoping that the results of this research can help us identify students who are potentially successful in order to provide the appropriate supports needed to help them succeed. It is only because of my role here at the University that I have chosen this research topic. I believe the University would benefit from the results of this study.

If the data is not available to me, I need to move forward and begin conceptualizing a new study. I do appreciate your consideration of this request. I hope that we can get a resolution quickly.

Respectfully,

Sherri L. Stepp
Director of University College
Marshall University
One John Marshall Drive
Huntington, WV 25755
(304) 696-7038
goodall@marshall.edu

APPENDIX B: IRB Approval

MARSHALL UNIVERSITY®
www.marshall.edu

Office of Research Integrity
Institutional Review Board
One John Marshall Drive
Huntington, WV 25755

FWA 00002704

IRB1 #00002205
IRB2 #00003206

December 10, 2015

Ron Childress, Ed.D.
College of Education and Professional Development

RE: IRBNet ID# 833973-1
At: Marshall University Institutional Review Board #2 (Social/Behavioral)

Dear Dr. Childress:

Protocol Title:	[833973-1] Evaluating High School Performance Measures for Predicting Remedial Mathematics Success and Student Retention: Implications for Higher Education Administrators
Expiration Date:	December 10, 2016
Site Location:	MUGC
Submission Type:	New Project APPROVED
Review Type:	Exempt Review

In accordance with 45CFR46.101(b)(4), the above study was granted Exempted approval today by the Marshall University Institutional Review Board #2 (Social/Behavioral) Designee for the period of 12 months. The approval will expire December 10, 2016. A continuing review request for this study must be submitted no later than 30 days prior to the expiration date.

This study is for student Sherri Stepp.

If you have any questions, please contact the Marshall University Institutional Review Board #2 (Social/Behavioral) Coordinator Bruce Day, ThD, CIP at 304-696-4303 or day50@marshall.edu. Please include your study title and reference number in all correspondence with this office.

APPENDIX C: Supporting Tables for Research Question 4

Table C1. Chi-Square Results from Comparison of Sex and Success in MTH 099 (Basic Skills in Mathematics II) or MTH 121 (Concepts and Applications) for Fall-to-Fall Retention by Entering Freshman Cohort

Cohort & Sex	Students Succeeding in MTH 099						Students Succeeding in MTH 121					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
	n	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.91	.34					3.07	.08
Male	14	77.8	4	22.2			6	75.0	2	25.0		
Female	23	88.5	3	11.5			23	95.8	1	2.3		
Cohort 2 – Fall 2011 Entry					1.12	.29					.24	.63
Male	10	90.9	1	9.1			13	92.9	1	7.1		
Female	29	76.3	9	23.7			26	96.3	1	3.7		
Cohort 3 – Fall 2012 Entry					.08	.77					1.82	.18
Male	15	75.0	5	25.0			7	77.8	2	22.2		
Female	29	78.4	8	21.6			38	92.7	3	7.3		
Cohort 4 – Fall 2013 Entry					.20	.65					3.01	.08
Male	17	85.0	3	15.0			16	100.0	0	0.0		
Female	24	80.0	6	20.0			30	83.3	6	16.7		
Cohort 5 – Fall 2014 Entry					2.74	.10					.02	.90
Male	9	75.0	3	25.0			8	72.7	3	27.3		
Female	19	95.0	1	5.0			12	75.0	4	25.0		

n = 856

Table C2. Chi-Square Results from Comparison of Sex and Success in MTH 127 (College Algebra Expanded) or MTH 130 (College Algebra) for Fall-to-Fall Retention by Entering Freshman Cohort

	Students Succeeding in MTH 127						Students Succeeding in MTH 130					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
Cohort & Sex	*n*	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					1.24	.27					1.63	.20
Male	13	76.5	4	23.5			8	100.0	0	0.0		
Female	18	90.0	2	10.0			9	81.8	2	18.2		
Cohort 2 – Fall 2011 Entry					.11	.74					.09	.76
Male	16	94.1	1	5.9			7	87.5	1	12.5		
Female	21	91.3	2	8.7			11	91.7	1	8.3		
Cohort 3 – Fall 2012 Entry					.36	.55					.34	.56
Male	11	91.7	1	8.3			8	80.0	2	20.0		
Female	16	84.2	3	15.8			15	88.2	2	11.8		
Cohort 4 – Fall 2013 Entry					.86	.35					1.88	.17
Male	11	78.6	3	21.4			7	70.0	3	30.0		
Female	18	90.0	2	10.0			5	100.0	0	0.0		
Cohort 5 – Fall 2014 Entry					1.27	.26					.87	.35
Male	4	66.7	2	33.3			2	50.0	2	50.0		
Female	14	87.5	2	12.5			9	75.0	3	25.0		

n = 856

Table C3. Chi-Square Results from Comparison of Ethnicity and Success in MTH 099 (Basic Skills in Mathematics II) or MTH 121 (Concepts and Applications) for Fall-to-Fall Retention by Entering Freshman Cohort

	Students Succeeding in MTH 099						Students Succeeding in MTH 121					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
Cohort & Ethnicity	*n*	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.06	.81					.39	.53
White	33	94.3	2	5.7			23	88.5	3	11.5		
Black	1	100.0	0	0.0			3	100.0	0	0.0		
Cohort 2 – Fall 2011 Entry					1.77	.18						
White	26	76.5	8	23.5			24	96.0	1	4.0	.12	.72
Black	6	100.0	0	0.0			3	100.0	0	0.0		
Cohort 3 – Fall 2012 Entry					.56	.45					*	*
White	31	83.8	6	16.2			34	94.4	2	5.6		
Black	2	66.7	1	33.3			0	0.0	0	0.0		
Cohort 4 – Fall 2013 Entry					1.04	.31					1.17	.28
White	29	87.9	4	12.1			38	88.4	5	11.6		
Black	2	66.7	1	33.3			2	66.7	1	33.3		
Cohort 5 – Fall 2014 Entry					3.31	.07					.65	.42
White	23	92.0	2	8.0			16	76.2	5	23.8		
Black	1	50.0	1	50.0			1	50.0	1	50.0		

n = 856; **No statistics are computed because two ethnicity variable cells are empty.*

Table C4. Chi-Square Results from Comparison of Ethnicity and Success in MTH 127 (College Algebra Expanded) or MTH 130 (College Algebra) for Fall-to-Fall Retention by Entering Freshman Cohort

	Students Succeeding in MTH 127						Students Succeeding in MTH 130					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
Cohort & Ethnicity	*n*	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.11	.74					.07	.80
White	27	90.0	3	10.0			15	93.8	1	6.2		
Black	1	100.0	0	0.0			1	100.0	0	0.0		
Cohort 2 – Fall 2011 Entry					.21	.65					*	*
White	24	96.0	1	4.0			12	92.3	1	7.7		
Black	5	100.0	0	0.0			0	0.0	0	0.0		
Cohort 3 – Fall 2012 Entry					*	*					.23	.63
White	21	91.3	2	8.7			17	89.5	2	10.5		
Black	0	0.0	0	0.0			2	100.0	0	0.0		
Cohort 4 – Fall 2013 Entry					.05	.83					.29	.59
White	22	95.7	1	4.3			10	76.9	3	23.1		
Black	1	100.0	0	0.0			1	100.0	0	0.0		
Cohort 5 – Fall 2014 Entry					*	*					1.15	.28
White	16	80.0	4	20.0			8	61.5	5	38.5		
Black	0	0.0	0	0.0			2	100.0	0	0.0		

n = 856; **No statistics are computed because two ethnicity variable cells are empty.*

Table C5. Chi-Square Results from Comparison of Father's Education Level and Success in MTH 099 (Basic Skills in Mathematics II) or MTH 121 (Concepts and Applications) for Fall-to-Fall Retention by Entering Freshman Cohort

Cohort & Father's Education Level	Students Succeeding in MTH 099						Students Succeeding in MTH 121					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
	n	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.84	.36					.83	.36
High School or Lower	26	86.7	4	13.3			21	87.5	3	12.5		
College or Beyond	9	75.0	3	25.0			6	100.0	0	0.0		
Cohort 2 – Fall 2011 Entry					.00	.96					.26	.61
High School or Lower	23	79.3	6	20.7			25	96.2	1	3.8		
College or Beyond	12	80.0	3	20.0			12	92.3	1	7.7		
Cohort 3 – Fall 2012 Entry					.03	.86					3.85	.05
High School or Lower	28	77.8	8	22.2			32	94.1	2	5.9		
College or Beyond	12	80.0	3	20.0			8	72.7	3	27.3		
Cohort 4 – Fall 2013 Entry					1.99	.16					.79	.37
High School or Lower	24	77.4	7	22.6			25	86.2	4	13.8		
College or Beyond	15	93.8	1	6.2			17	94.4	1	5.6		
Cohort 5 – Fall 2014 Entry					3.54	.06					1.05	.31
High School or Lower	12	80.0	3	20.0			7	63.6	4	36.4		
College or Beyond	16	100.0	0	0.0			13	81.2	3	18.8		

n = 856

Table C6. Chi-Square Results from Comparison of Father's Education Level and Success in MTH 127 (College Algebra Expanded) or MTH 130 (College Algebra) for Fall-to-Fall Retention by Entering Freshman Cohort

Cohort & Father's Education Level	Students Succeeding in MTH 127						Students Succeeding in MTH 130					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
	n	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.51	.47					2.25	.13
High School or Lower	19	86.4	3	13.6			9	100.0	0	0.0		
College or Beyond	10	76.9	3	23.1			7	77.8	2	22.2		
Cohort 2 – Fall 2011 Entry					.17	.68					.01	.94
High School or Lower	19	90.5	2	9.5			9	90.0	1	10.0		
College or Beyond	16	94.1	1	5.9			8	88.9	1	11.1		
Cohort 3 – Fall 2012 Entry					.35	.55					.07	.79
High School or Lower	17	89.5	2	10.5			6	85.7	1	14.3		
College or Beyond	9	81.8	2	18.2			17	89.5	2	10.5		
Cohort 4 – Fall 2013 Entry					.18	.67					.07	.79
High School or Lower	18	85.7	3	14.3			7	77.8	2	22.2		
College or Beyond	10	90.9	1	9.1			5	83.3	1	16.7		
Cohort 5 – Fall 2014 Entry					.04	.84					.00	1.00
High School or Lower	8	80.0	2	20.0			5	71.4	2	28.6		
College or Beyond	10	83.3	2	16.7			5	71.4	2	28.6		

n = 856

Table C7. Chi-Square Results from Comparison of Mother's Education Level and Success in MTH 099 (Basic Skills in Mathematics II) or MTH 121 (Concepts and Applications) for Fall-to-Fall Retention by Entering Freshman Cohort

	Students Succeeding in MTH 099						Students Succeeding in MTH 121					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
Cohort & Mother's Education Level	*n*	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.40	.53					2.22	.14
High School or Lower	25	86.2	4	13.8			15	83.3	3	16.7		
College or Beyond	11	78.6	3	21.4			12	100.0	0	0.0		
Cohort 2 – Fall 2011 Entry					.28	.60					.05	.83
High School or Lower	16	76.2	5	23.8			16	94.1	1	5.9		
College or Beyond	19	82.6	4	17.4			22	95.7	1	4.3		
Cohort 3 – Fall 2012 Entry					.00	.99					.01	.94
High School or Lower	24	77.4	7	22.6			25	89.3	3	10.7		
College or Beyond	17	77.3	5	22.7			18	90.0	2	10.0		
Cohort 4 – Fall 2013 Entry					1.56	.21					4.78	.03
High School or Lower	17	73.9	6	26.1			16	76.2	5	23.8		
College or Beyond	22	88.0	3	12.0			28	96.6	1	3.4		
Cohort 5 – Fall 2014 Entry					.65	.42					.02	.90
High School or Lower	11	84.6	2	15.4			12	75.0	4	25.0		
College or Beyond	15	93.8	1	6.2			8	72.7	3	27.3		

n = 856

Table C8. Chi-Square Results from Comparison of Mother's Education Level and Success in MTH 127 (College Algebra Expanded) or MTH 130 (College Algebra) for Fall-to-Fall Retention by Entering Freshman Cohort

Cohort & Mother's Education Level	Students Succeeding in MTH 127						Students Succeeding in MTH 130					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
	n	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					3.74	.54					.06	.81
High School or Lower	19	86.4	3	13.6			7	87.5	1	12.5		
College or Beyond	11	78.6	3	21.4			10	90.9	1	9.1		
Cohort 2 – Fall 2011 Entry					2.93	.09					.74	.39
High School or Lower	17	85.0	3	15.0			5	100.0	0	0.0		
College or Beyond	18	100.0	0	0.0			13	86.7	2	13.3		
Cohort 3 – Fall 2012 Entry					.63	.43					.15	.70
High School or Lower	12	92.3	1	7.7			8	88.9	1	11.1		
College or Beyond	14	82.4	3	17.6			15	83.3	3	16.7		
Cohort 4 – Fall 2013 Entry					.11	.74					.00	1.00
High School or Lower	17	89.5	2	10.5			4	80.0	1	20.0		
College or Beyond	12	85.7	2	14.3			8	80.0	2	20.0		
Cohort 5 – Fall 2014 Entry					.47	.49					3.76	.05
High School or Lower	9	75.0	3	25.0			2	40.0	3	60.0		
College or Beyond	7	87.5	1	12.5			8	88.9	1	11.1		

n = 856

Table C9. Chi-Square Results from Comparison of Pell Grant Eligibility and Success in MTH 099 (Basic Skills in Mathematics II) or MTH 121 (Concepts and Applications) for Fall-to-Fall Retention by Entering Freshman Cohort

	Students Succeeding in MTH 099						Students Succeeding in MTH 121					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
Cohort & Pell Grant Eligibility	*n*	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.02	.90					2.27	.13
Eligible	23	85.2	4	14.8			16	84.2	3	15.8		
Not Eligible	13	86.7	2	13.3			13	100.0	0	0.0		
Cohort 2 – Fall 2011 Entry					.12	.73					2.21	.14
Eligible	21	77.8	6	22.2			21	100.0	0	0.0		
Not Eligible	18	81.8	4	18.2			18	90.0	2	10.0		
Cohort 3 – Fall 2012 Entry					4.06	.04					.74	.39
Eligible	23	67.6	11	32.4			18	85.7	3	14.3		
Not Eligible	20	90.9	2	9.1			27	93.1	2	6.9		
Cohort 4 – Fall 2013 Entry					2.50	.11					.11	.74
Eligible	20	74.1	7	25.9			22	91.7	2	8.3		
Not Eligible	21	91.3	2	8.7			24	88.9	3	11.1		
Cohort 5 – Fall 2014 Entry					.88	.35					2.05	.15
Eligible	14	82.4	3	17.6			8	61.5	5	38.5		
Not Eligible	14	93.3	1	6.7			12	85.7	2	14.3		

n = 856

Table C10. Chi-Square Results from Comparison of Pell Grant Eligibility and Success in MTH 127 (College Algebra Expanded) or MTH 130 (College Algebra) for Fall-to-Fall Retention by Entering Freshman Cohort

	Students Succeeding in MTH 127						Students Succeeding in MTH 130					
	Enrolled Second Fall		Not Enrolled Second Fall				Enrolled Second Fall		Not Enrolled Second Fall			
Cohort & Pell Grant Eligibility	*n*	%	*n*	%	X^2	*p*	*n*	%	*n*	%	X^2	*p*
Cohort 1 – Fall 2010 Entry					.00	1.00					1.30	.25
Eligible	18	85.7	3	14.3			7	100.0	0	0.0		
Not Eligible	12	85.7	2	14.3			10	83.3	2	16.7		
Cohort 2 – Fall 2011 Entry					.11	.74					.56	.46
Eligible	21	91.3	2	8.7			4	100.0	0	0.0		
Not Eligible	16	94.1	1	5.9			14	87.5	2	12.5		
Cohort 3 – Fall 2012 Entry					.87	.35					2.35	.13
Eligible	13	81.2	3	18.8			9	100.0	0	0.0		
Not Eligible	13	92.9	1	7.1			14	77.8	4	22.2		
Cohort 4 – Fall 2013 Entry					.16	.69					1.11	.29
Eligible	9	81.8	2	18.2			4	66.7	2	33.3		
Not Eligible	20	87.0	5	14.7			8	88.9	1	11.1		
Cohort 5 – Fall 2014 Entry					.11	.75					.78	.38
Eligible	6	85.7	1	14.3			4	57.1	3	42.9		
Not Eligible	12	80.0	3	20.0			7	77.8	2	22.2		

n = 856

Table C11. Independent Samples T-test Results from Comparison of Estimated Family Contribution by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

Course & Cohort	Enrolled Second Fall			Not Enrolled Second Fall				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	37	6692	11224	7	4173	6836	.57	.57
Cohort 2	39	10043	13679	10	7208	10265	.61	.54
Cohort 3	44	8638	12999	13	3177	5772	1.47	.15
Cohort 4	41	11950	17008	9	3499	5419	1.46	.15
Cohort 5	28	11009	16725	4	2744	3853	.97	.34
MTH 121 (Concepts and Applications)								
Cohort 1	29	6537	7354	3	1093	1893	1.26	.22
Cohort 2	39	10342	12282	2	8599	1484	.20	.84
Cohort 3	45	10769	11984	5	3813	4662	1.28	.21
Cohort 4	46	13987	23074	6	8660	7276	.56	.58
Cohort 5	20	9557	9277	7	4533	5699	1.34	.19
MTH 127 (College Algebra Expanded)								
Cohort 1	31	8054	12098	6	3055	4145	.99	.33
Cohort 2	37	11386	15109	3	7809	11035	.40	.69
Cohort 3	27	12973	15800	3	2508	2246	1.13	.27
Cohort 4	28	16414	20751	5	6128	6605	1.09	.29
Cohort 5	18	12810	14387	4	14710	14268	-2.40	.81
MTH 130 (College Algebra)								
Cohort 1	17	16316	25329	1	27363	*	-.42	.68
Cohort 2	18	15933	17048	2	5683	561	.83	.42
Cohort 3	23	10962	11807	4	50000	38061	-4.19	.00
Cohort 4	12	9105	7818	3	2986	4202	1.29	.22
Cohort 5	11	13909	20092	5	13187	15961	.07	.95

n = 856; **t cannot be computed because at least one of the groups is empty.*

Table C12. Independent Samples T-test Results from Comparison of Unmet Need by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

	Enrolled Second Fall			Not Enrolled Second Fall				
Course & Cohort	*n*	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	37	1738	2983	7	1798	1750	-.05	.96
Cohort 2	39	1547	3022	10	1777	3232	-.21	.83
Cohort 3	44	2030	3422	13	2920	4178	-.78	.44
Cohort 4	41	959	3380	9	2742	5653	-1.23	.22
Cohort 5	28	1929	2931	4	2164	1794	-.16	.88
MTH 121 (Concepts and Applications)								
Cohort 1	29	327	3337	3	1157	1002	-.42	.68
Cohort 2	39	344	3952	2	1261	5132	-.32	.75
Cohort 3	45	-114	3859	5	1956	1694	-1.18	.25
Cohort 4	46	277	3313	6	-679	4942	.63	.53
Cohort 5	20	-665	3593	7	2597	3317	-2.10	.06
MTH 127 (College Algebra Expanded)								
Cohort 1	31	1080	2653	6	3907	2788	-2.37	.02
Cohort 2	37	252	3797	3	4885	5276	-1.98	.05
Cohort 3	27	1191	4429	4	1428	4239	-.10	.92
Cohort 4	29	818	5006	5	3098	3542	-.97	.34
Cohort 5	18	1226	1960	4	-519	4696	1.23	.23
MTH 130 (College Algebra)								
Cohort 1	17	-1383	3268	2	-3750	3536	.96	.35
Cohort 2	18	-2736	5276	2	1779	2630	-1.17	.26
Cohort 3	23	-1570	4618	4	-2688	4879	.44	.66
Cohort 4	12	-1740	4688	3	3328	4406	-1.69	.12
Cohort 5	11	-1274	5314	5	1408	6885	-.86	.41

$n = 856$

Table C13. Independent Samples T-test Results from Comparison of Overall High School Grade Point Average by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

Course & Cohort	Enrolled Second Fall			Not Enrolled Second Fall				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	37	3.27	.41	7	3.00	.46	1.58	.12
Cohort 2	39	3.33	.52	10	3.31	.74	.01	.92
Cohort 3	44	3.30	.47	13	3.24	.55	.38	.70
Cohort 4	41	3.32	.53	9	3.11	.26	1.12	.27
Cohort 5	28	3.28	.52	4	3.45	.07	-.62	.54
MTH 121 (Concepts and Applications)								
Cohort 1	29	3.48	.46	3	3.31	.48	.60	.56
Cohort 2	39	3.32	.51	2	3.83	.56	-1.36	.18
Cohort 3	45	3.43	.49	5	3.44	.65	-.02	.97
Cohort 4	46	3.42	.48	6	3.63	.30	-1.06	.29
Cohort 5	20	3.71	.44	7	3.59	.37	.67	.51
MTH 127 (College Algebra Expanded)								
Cohort 1	31	3.36	.42	6	2.96	.49	2.03	.05
Cohort 2	37	3.41	.46	3	3.55	.50	-.51	.61
Cohort 3	27	3.58	.33	4	3.18	.44	2.20	.04
Cohort 4	29	3.34	.52	5	3.45	.45	-.45	.66
Cohort 5	18	3.63	.39	4	3.21	.56	1.80	.09
MTH 130 (College Algebra)								
Cohort 1	17	3.93	.29	2	3.66	.02	1.32	.21
Cohort 2	18	3.89	.51	2	4.02	.01	-.36	.72
Cohort 3	23	3.82	.28	4	3.54	.28	1.84	.08
Cohort 4	12	3.81	.20	3	3.39	.48	2.50	.03
Cohort 5	11	3.91	.28	5	3.68	.39	1.33	.21

n = 856

Table C14. Independent Samples T-test Results from Comparison of High School Math Grade Point Average by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

Course & Cohort	Enrolled Second Fall			Not Enrolled Second Fall				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	36	2.77	.62	5	2.07	.60	2.38	.02
Cohort 2	38	2.77	.77	10	2.51	.95	.93	.36
Cohort 3	43	2.67	.70	13	2.62	.83	.23	.82
Cohort 4	41	2.55	.81	8	2.61	.39	-.23	.82
Cohort 5	28	2.62	.76	4	3.19	.38	-1.45	.16
MTH 121 (Concepts and Applications)								
Cohort 1	29	2.95	.71	3	2.14	.47	1.93	.06
Cohort 2	38	2.69	.84	2	2.75	.35	-.11	.92
Cohort 3	45	2.71	.73	5	2.58	1.03	.36	.72
Cohort 4	46	2.67	.85	6	3.04	.80	-1.01	.32
Cohort 5	20	3.18	.74	7	3.25	.50	-.21	.84
MTH 127 (College Algebra Expanded)								
Cohort 1	29	2.89	.66	4	2.25	.50	1.84	.08
Cohort 2	36	2.90	.71	3	3.19	.76	-.70	.49
Cohort 3	27	2.97	.72	4	2.44	.47	1.41	.17
Cohort 4	29	2.70	.65	5	3.30	.65	-1.94	.06
Cohort 5	18	3.01	.61	4	2.19	.52	2.51	.21
MTH 130 (College Algebra)								
Cohort 1	16	3.60	.54	2	2.63	.18	2.46	.03
Cohort 2	18	3.39	.94	1	3.75	*	-.37	.72
Cohort 3	22	3.36	.55	4	2.96	.62	1.34	.19
Cohort 4	12	2.97	.67	3	2.89	.84	.18	.86
Cohort 5	11	3.49	.50	5	3.50	.59	-.03	.98

n = 856; **t cannot be computed because at least one of the groups is empty.*

Table C15. Independent Samples T-test Results from Comparison of Highest ACT Math Score by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

Course & Cohort	Enrolled Second Fall			Not Enrolled Second Fall				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	37	16.81	1.43	7	17.14	1.46	-.56	.58
Cohort 2	39	17.13	1.58	10	17.10	.74	.06	.96
Cohort 3	44	16.75	1.22	13	17.00	1.00	-.67	.50
Cohort 4	41	17.07	1.01	8	16.50	1.07	1.46	.15
Cohort 5	28	16.57	.84	4	16.75	.96	-.39	.70
MTH 121 (Concepts and Applications)								
Cohort 1	28	18.71	2.44	3	21.67	1.53	-2.03	.05
Cohort 2	39	19.13	3.05	2	21.00	5.66	-.82	.42
Cohort 3	45	18.82	2.93	5	18.80	2.28	.02	.99
Cohort 4	46	19.48	3.56	6	20.17	2.86	-.45	.65
Cohort 5	20	21.15	2.83	7	20.71	3.64	.33	.75
MTH 127 (College Algebra Expanded)								
Cohort 1	31	18.03	2.26	6	18.00	.89	.03	.97
Cohort 2	36	18.69	2.52	3	19.33	1.16	-.43	.67
Cohort 3	27	18.30	1.98	4	19.75	2.87	-1.30	.20
Cohort 4	29	18.69	2.82	5	20.00	3.74	-.92	.37
Cohort 5	18	18.72	1.71	4	19.00	.82	-.31	.76
MTH 130 (College Algebra)								
Cohort 1	16	22.63	2.28	2	23.50	.71	-.53	.61
Cohort 2	17	23.82	2.65	2	23.00	2.83	.41	.68
Cohort 3	23	23.04	2.01	4	22.25	1.50	.75	.46
Cohort 4	12	22.67	2.23	3	24.00	4.36	-.77	.45
Cohort 5	11	24.36	2.20	5	22.40	.90	1.90	.08

n = 856

Table C16. Independent Samples T-test Results from Comparison of Highest SAT Math Score by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

Course & Cohort	Enrolled Second Fall			Not Enrolled Second Fall				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	3	386.67	51.32	1	440.00	*	-.90	.46
Cohort 2	4	440.00	42.43	2	395.00	35.36	1.27	.27
Cohort 3	6	390.00	41.47	0	*	*	*	*
Cohort 4	3	406.67	30.55	2	425.00	35.36	-.62	.58
Cohort 5	2	360.00	99.00	1	400.00	*	-.33	.80
MTH 121 (Concepts and Applications)								
Cohort 1	1	400.00	*	0	*	*	*	*
Cohort 2	5	446.00	34.35	1	370.00	*	2.02	.11
Cohort 3	8	431.25	94.63	1	570.00	*	-1.38	.21
Cohort 4	5	442.00	59.33	0	*	*	*	*
Cohort 5	4	472.50	60.76	3	406.67	11.58	1.81	.13
MTH 127 (College Algebra Expanded)								
Cohort 1	3	376.67	50.33	0	*	*	*	*
Cohort 2	8	468.75	64.68	0	*	*	*	*
Cohort 3	4	420.00	108.63	1	560.00	*	-1.15	.33
Cohort 4	2	455.00	21.21	2	445.00	63.64	.21	.85
Cohort 5	1	430.00	*	0	*	*	*	*
MTH 130 (College Algebra)								
Cohort 1	4	547.50	42.72	0	*	*	*	*
Cohort 2	4	482.50	20.62	0	*	*	*	*
Cohort 3	5	492.00	30.33	1	540.00	*	-1.45	.22
Cohort 4	2	525.00	7.07	0	*	*	*	*
Cohort 5	2	515.00	176.78	0	*	*	*	*

n = 856; **t cannot be computed because at least one of the groups is empty.*

Table C17. Independent Samples T-test Results from Comparison of High School Attendance Percentage by Mathematics Course and Entering Freshman Cohort for Fall-to-Fall Retention

Course & Cohort	Enrolled Second Fall			Not Enrolled Second Fall				
	n	*M*	*SD*	*n*	*M*	*SD*	*t*	*p*
MTH 099 (Basic Skills in Mathematics II)								
Cohort 1	20	93.7	.04	3	94.7	.02	-.42	.68
Cohort 2	29	94.5	.05	6	90.0	.07	2.00	.05
Cohort 3	33	94.3	.05	11	91.1	.05	1.80	.08
Cohort 4	22	92.0	.07	5	94.6	.04	-.84	.41
Cohort 5	12	92.8	.06	2	92.0	.06	.18	.86
MTH 121 (Concepts and Applications)								
Cohort 1	19	94.5	.03	2	92.5	.05	.89	.39
Cohort 2	27	93.4	.05	1	99.0	*	-1.12	.27
Cohort 3	34	94.3	.04	4	95.3	.02	-.49	.63
Cohort 4	25	94.4	.05	3	96.0	.02	-.57	.57
Cohort 5	14	93.0	.05	5	92.6	.03	.16	.88
MTH 127 (College Algebra Expanded)								
Cohort 1	15	93.1	.05	3	96.0	.01	-1.01	.33
Cohort 2	28	94.3	.05	3	92.7	.06	.54	.60
Cohort 3	21	95.1	.04	1	91.0	*	1.12	.28
Cohort 4	19	92.3	.07	2	98.0	.01	-1.13	.27
Cohort 5	7	92.7	.04	3	96.3	.05	-1.35	.21
MTH 130 (College Algebra)								
Cohort 1	10	95.1	.03	1	96.0	*	*	.78
Cohort 2	14	96.1	.03	0	*	*	*	*
Cohort 3	17	95.7	.03	2	95.0	.03	.34	.74
Cohort 4	11	96.0	.03	2	93.5	.02	1.30	.24
Cohort 5	10	95.0	.05	3	92.0	.05	.89	.39

n = 856; **t cannot be computed because at least one of the groups is empty.*

CURRICULUM VITAE

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EDUCATION

In Progress	Ed.D., Higher Education Leadership (ABD, December 2014), Marshall University (ABD) Dissertation: *Evaluating High School Mathematics Performance Measures and Student Attributes for Predicting Remedial Mathematics Success and Student Retention in College*
December 2014	Ed.S., Curriculum and Instruction, Marshall University
December 2004	M.S., Adult and Technical Education, Marshall University
May 1987	B.A., Advertising Journalism, Marshall University

PROFESSIONAL EMPLOYMENT

December 2009 to Present

Director of University College
Marshall University

- Directly oversee University College including supervision of five Academic Counselor II positions and one Program Assistant
- Develop, implement, and evaluate University College policies and procedures in coordination with the University mission and expectations
- Oversee the review of conditionally admitted and undecided student academic records to determine good standing, academic probation, suspensions, dismissals, and eligibility to declare academic majors
- Serve as chair of University Studies courses (UNI 100 Freshman First Class, UNI 101 New Student Seminar, UNI 102 Strategies for Academic Success, UNI 103 Career Planning for Undecided Students, UNI 201 Peer Mentoring, and UNI 400 Graduate School Preparation)
- Oversee multiple budgets within University College and Academic Affairs for special projects including Week of Welcome and Math Summer Bridge. Budgets total approximately $1 million.

- Supervise advising loads for Academic Counselors
- Maintain a direct advising load of approximately 25 student athletes and readmitted students including all correspondence, appointments, maintenance of advising records, and development of academic improvement plans for probation students
- Coordinate University College advising sessions for New Student Orientation
- Represent University College at Green & White Days, Preview Days and other events.
- Coordinate Math Summer Bridge Program for approximately 200 remedial math students
- Indirectly supervise Tutoring Services including multiple graduate assistants and student assistant peer tutors, National Student Exchange, math and chemistry placement exams
- Coordinate catalog updates, other University College publications, and website
- Work diligently to maintain an open and communicative work environment for all staff
- Assisted in the implementation of the Student Resource Center in 2010 and assisted in the transition to a new mission and vision in 2015 under a new name to be determined.

Current Committee Service
Strategic Enrollment Planning Council
Strategic Enrollment Planning Council Steering Committee
Strategic Enrollment Planning Council Work Group for Advising Platform, Work Group Lead
Week of Welcome / UNI 100 Planning Committee, Co-Chair
Associate Dean's Council
University Advising Task Force
University Assessment Committee
Intercultural Scholarship Committee
Herd Path Partners Faculty Advisory Council
Admission Appeals Committee

Recent Search Committees
Assistant Registrar (Chair), 2016
Vice President for Student Affairs, 2016
Veteran's Advocate (Chair), 2015
Assistant Dean of Student Life, 2015
Associate Vice President for Academic Affairs and Dean of Undergraduate Studies, 2015
Associate Vice President for Academic Affairs and Dean of Undergraduate Studies, 2012

July 2006 to May 2012

Director of the John Marshall Emerging Leaders Institute
Marshall University

- Organized meetings, seminars, and other activities focused on leadership topics including ethics, integrity, values, diversity, community service, financial stability, and team building for a group of approximately 40 students
- Organized and created programming for local retreats
- Organized travel arrangements and programming for out-of-state retreats
- Prepared recruiting material and recruited new freshmen annually
- Served as a mentor for students participating in the program

February 2005 to November 2009

Coordinator of Parent Resources
Marshall University

- Served as University liaison for parents of prospective and current students
- Implemented and operated a toll-free parent hotline
- Implemented and edited a parent website
- Created and edited a Parent Resource Magazine
- Created and edited a Guide for Parents
- Hosted parents during summer orientation programs and activities
- Organized and publicized Parent & Family Weekend activities and hosted parents
- Coordinated free airport shuttle service for students during school breaks
- Coordinated Countdown to Commencement event for graduating seniors

November 1990 to January 2005

Financial Aid Counselor Senior
Marshall University

- Maintained up-to-date knowledge and accurate interpretation of the federal regulations of the Higher Education Act of 1965 and its amendments, the Student Financial Aid Handbook, and the Compiled Federal Regulations (CFR)
- Assisted in the creation of policies and procedures for the administration and delivery of aid
- Provided direct oversight of Ford Federal Direct Student Loans and Parent Loans

- Served as primary advisor for students enrolled in the nurse anesthesia program and the secondary advisor for medical students
- Implemented use of an office timeline incorporating annual office functions
- Calculated student expense budgets for use in awarding procedures
- Counseled students and parents
- Assessed student need, packaged awards, verified enrollment, and adjusted aid as needed
- Verified accuracy of student and parent financial data as reported on FAFSA
- Reviewed student compliance with satisfactory academic progress and reviewed appeals
- Implemented and maintained financial aid website
- Designed and edited financial aid brochures, newsletters, award notifications, institutional applications, and other publications
- Edited and updated financial aid sections of University publications including the undergraduate catalog, the graduate catalog, and the student handbook
- Prepared and presented workshops for students, parents, counselors, and University staff
- Represented Marshall at state and regional financial aid associations and training
- Supervised support staff for front-line customer service

February 1988 to November 1990

Grant Program Administrator
West Virginia Higher Education Grant Program
West Virginia Board of Regents (Now the West Virginia Higher Education Policy Commission)

- Directed distribution of Grant Program funds to colleges and universities
- Processed applicant and parent financial data
- Counseled students and parents
- Compiled the Student Financial Assistance Survey for West Virginia Colleges and Universities
- Prepared and presented workshops at West Virginia high schools and state meetings
- Represented the Grant Program at state and regional financial aid association meetings
- Edited annual newsletter for high school guidance counselors
- Addressed inquiries from third parties including legislative members and the Governor
- Supervised support staff members

CLASSES TAUGHT

UNI 100 Freshman First Class: UNI 100 is an introduction to the academic structures and expectations of the university. As a transitional course, UNI 100 consists of two parts: (1) attending large group sessions and small class sessions during Week of Welcome and (2) attending seven additional 50-minute class sessions, once per week in the first seven weeks of the semester. *Fall 2016*

UNI 400 Graduate School Preparation: UNI 400 provides the necessary steps, tools, and resources future graduates need in completing their undergraduate career and pursuing a graduate degree. It is designed for students who will be graduating within the year (junior and senior class standing) and are interested in researching and applying for graduate school in order to continue their education. *Fall 2015 to Present*

UNI 101 New Student Seminar: UNI 101 is designed as an introduction to college life and intended for freshmen. Taught by University College advisors, the course provides students with an opportunity to adjust to the academic and social environment of college under the guidance of an advisor and in the presence of a small group of peers**.** *Fall 2006 to 2014*

GRANTS

Primary Investigator
West Virginia Higher Education Policy Commission 2016 Math Summer Bridge Grant ($40,000)

Primary Investigator
West Virginia Higher Education Policy Commission 2015 Math Summer Bridge Grant ($50,000)

Primary Investigator
West Virginia Higher Education Policy Commission 2014 Math Summer Bridge Grant ($50,000)

PROFESSIONAL PRESENTATIONS

Bridging the Math Gap
West Virginia Association of Academic Administrators (WVAAA), Flatwoods, WV; September 2014
Co-Presenters: Amber Bentley, Laura Stapleton

Evaluating Developmental Education Programs: A Proposed Model and Guidelines for Higher Education Administrators

Southern Regional Council on Educational Administration (SRCEA), Oklahoma City, OK; October 2013

Bridge Programs at Marshall University and New River Community & Technical College: A Panel Discussion
West Virginia Developmental Education Summit (WVHEPC and CTCSWV), Stonewall Resort, Walkersville, WV; June 2013

A Multi-Faceted Approach to Student Persistence
West Virginia Association of Academic Administrators (WVAAA), Stonewall Resort, Walkersville, WV; March 2013
Co-Presenters: Matthew James

Providing Consistency in Freshman Seminar Content through Master Teachers and Video Delivery
32nd Annual Conference on the First Year Experience, Orlando, FL; Feb. 2013
Co-Presenters: Dr. Corley Dennison, Sonja Cantrell

TRAINING

Noel-Levitz Connections Customer Service Trainer
Summer and Fall 2012

CURRENT MEMBERSHIPS

Member, National Academic Advising Association (NACADA)

PUBLICATIONS

Evaluating Developmental Education Programs: A Proposed Model and Guidelines for Higher Education Administrators
National Social Science Journal, Volume 44, Number 2, 2015.

Week of Welcome: Building a "First-Class" Tradition
eSource for College Transitions, April 2013, National Research Center for the First-Year Experience and Students in Transition

PROFESSIONAL CONFERENCES AND TRAINING OPPORTUNITIES

February 2015	34th Annual Conference on the First-Year Experience; Dallas, TX
July 2014	Appreciative Advising Institute; Louisville, KY
July 2013	Carnegie Foundation for the Advancement of Teaching, National Pathways Forum, Santa Cruz, CA

February 2013	32nd Annual Conference on the First-Year Experience; Orlando, FL
July 2011	Noel-Levitz National Conference on Student Recruitment, Marketing, and Retention; Denver, CO
May 2011	National Academic Advising Association Region 3 Conference; Knoxville, TN
May 2010	National Academic Advising Association Region 3 Conference; Lexington, KY

HONORS AND AWARDS

2010, August	Marshall University Employee of the Month
2011, June	Marshall University Employee of the Year for 2010