DePaul University

College of Education

THE PREDICTIVE VALIDITY OF HIGH SCHOOL GRADES TO COLLEGE REMEDIAL MATHEMATICS PERFORMANCE

A Dissertation in Education
With a Concentration in Educational Leadership

by

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Submitted in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Education

May 2011

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Abstract

The concerns for remedial education are not new – as remedial education has a long history. Yet, the issues are gaining prominence in our discourse about improving the outcomes associated with post-secondary education. Any discussion of improvement is often accompanied by a discussion regarding the challenge posed to post-secondary institutions in meeting the growing remedial needs of the students that they receive.

The purpose of this research is to evaluate community college placement of students into remedial coursework through an examination of whether a student's high school mathematics preparation and mathematics grade average are a significant determinant of their completion of the remedial math sequence – as referenced by successful completion of the common midterm and final examinations. Stated differently, this study will attempt to derive the predictive validity of a student's high school grade point average and mathematics grade point average with respect to their performance on the common assessments (midterm and final) used in the remedial mathematics sequence.

A non-experimental, quantitative, correlational research design was used for the study.

Dedication

This dissertation is dedicated to my family and to the memory of a man who has inspired me through inspiring others, my grandfather, Edd Alexander Hall. Although, I personally remember very little about his life, his legacy lives through the many stories that I have heard regarding his quiet strength, personal conviction, love for his family, and commitment to helping others as told through the many people whose lives he has impacted. I know that you are my angel and pray that I will always make you proud in all that I do.

To my grandmother, Vivienne Hall-Diggs, who not only kept the memory of my grandfather present for me, but whose commitment to him defined for me the meaning and significance of marriage. Thank you for believing in me.

To my parents, Vann and John Dozier, whose love and support have never wavered. Rather, it has given me a foundation that has allowed me to build a life of meaning. I can say with great certainly that when growing up I never imagined earning a doctorate degree, and I am equally certain that you did not imagine it either. However, it is because of your enduring love and support of me that I am here today. Thank you for helping me to reach the finish line!

To my children, Olivia, Evans, and Sophia, I don't ever want to pressure you to be anything that your heart doesn't choose. However, I hope that the example that your mother and I provide will inspire you to be the best and whatever you choose. Thank you for giving me the time to complete this project. I love you with all of my heart and soul.

To my wife, Victoria, whose love, encouragement, support, friendship, and advice has given me everything that I have needed to accomplish every goal that I endeavor. I am the man that I am today only because of the woman that you are to me. I am so very blessed to have you as my life's partner. I love you.

Acknowledgements

I am very thankful to my committee chair, Andrea Kayne-Kaufman, whose guidance and encouragement not only helped me to complete this project, but also led me to choose DePaul University for my doctoral studies. Thank you for being a resource and mentor to me for nearly seven years.

To Fr. Patrick McDevitt, whose help in keeping me focused on the "so what" behind the statistical data made this both a theoretical and practical learning experience. Thank you for making this project more meaningful.

To Wayne D. Watson, who is the person most directly responsible for my career in education and who encouraged me to pursue a doctorate degree. You have been a mentor through this process and in my career endeavors. I cannot begin to express how thankful I am to you.

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Chapter I

Introduction to the Study

Introduction

Between 2006 and 2010 enrollment at City College – a community college within an urban city located in the Midwest section of the United States – has grown over 40%. However, the enrollment growth experienced at City College is not unique as community colleges across the nation have experienced similar increases. During this period of time, there has also been a renewed sense of urgency in our government's response to the concerns of education; whereby, there is a call for greater accountability not only to the primary and secondary institutions, but also post-secondary institutions. This call for greater accountability is a response to the nation's economic and employment crisis. In this regard, community colleges (in particular) have been identified as a key provider in fueling our nation's economic recovery and a vehicle by which students can improve workforce skills and access new job opportunities. Therefore, access to education is increasingly important; and, again, community colleges fill a unique need as the colleges are not just a place to receive job preparatory skills, but also a low cost alternative for many people who intend to transfer for baccalaureate completion. Yet, some argue that access is compromised by the placement testing policies that exist in community colleges. A functional definition of placement (or selection) testing can be found in Brown's 1999 research regarding placement testing and remedial mathematics for post-secondary students where he provides a quote from Glaser and Silver (1994), "Selection testing attempts to measure human abilities prior to a course of instruction so that

individuals can be appropriately placed, diagnosed, certified, included or excluded" (p. 395). It is in the last word of this quote – "excluded" – that Brown illuminates an equity position whereby he asserts that placement tests function to exclude people from post-secondary education rather than aid access as they (the tests) serve as an additional hurdle for those impacted (Brown, 1999). Placement tests have also been criticized (even litigated) because of people's concerns with predictive validity, discrimination, reliability, and the choice of cut scores (Brown, 1999).

The counter to the equity concern is the quality concern. By placing students into different ability groups (as an outcome of placement testing), faculty are able to focus on college-level material in college-level classes, rather than working to raise the skills of poorly prepared students who are trying to succeed in a college-level class (Ruiz, 2007).

The concerns for remedial education are not new – as remedial education has a long history. Yet, the issues are gaining prominence in our discourse about improving the outcomes associated with post-secondary education as articulated most recently by Vice President Joe Biden in his March, 2011 speech as he presented the "College Completion Tool Kit". The tool kit provides strategies to improve the accountability of post-secondary institutions such as performance-based funding, accelerate student learning and reduce the cost of education, and using data to drive decision making (United States Department of Education, 2011). While these are valid strategies, they also expose the tension that exists between secondary and post-secondary institutions – as so many high school graduates are ill-prepared for college-level work. Therefore, colleges spend resources helping to prepare students for college when the students should have been prepared for college by their high schools. Community colleges have an even

greater sensitivity to these concerns as open door institutions. Yet, institutional placement policies create barriers to college for many students when these policies prevent students from enrolling in courses in which they could be successful. "If institutions allocate opportunity based on test scores that do not adequately reflect the skills needed for course success, the mission of the community college to provide access to college-level courses for all is threatened. These types of policies are particularly harmful to low-income and minority students who often constitute the majority of students placed in remedial or developmental courses" (Marwick, 2004, p. 265). Placement testing has become regarded as an essential instrument of American education because of the increased emphasis on accountability. As the emphasis on accountability increases so does the tension between the community college mission of open access and high standards (Marwick, 2004). It is the concern for access and quality that inspires this research.

Problem Statement

Community colleges are charged with teaching students college-level material, yet a majority of the students arrive with academic skills in at least one subject area that are judged to be too weak to allow them to engage successfully in college-level work (Bailey, 2008). This is certainly true of the students who begin their post-secondary school matriculations at City College where (in academic year 2009-2010) 100% of the students tested by the college's placement test were deemed in need of mathematics remediation. In fact, this is not just a local concern as a recent study of data derived from Achieving the Dream: Community Colleges Count (a national initiative funded by the Lumina Foundation and others that involves eighty-three community colleges in fifteen

states) shows that 61% of students are referred to their institution's lowest level developmental math course (for institutions with two or more levels of developmental math). The data further shows that only 31% of those students who were referred to developmental math complete their developmental math sequence within three years of their initial assessment (Bailey, 2008).

Like many colleges, City College uses the COMPASS exam (Computerized Adaptive Placement Assessment and Support System – a computer generated, adaptive placement test developed by ACT) to assess incoming students' academic skills. The test scores (in consultation with predetermined cut-scores) determine whether a student is placed into remedial or college-level courses. Students whose test scores do not exceed the predetermined cut-scores for college-level placement are required to enroll in a sequence of one or more remedial courses before enrolling in college-level courses in that subject area.

Critics of college remedial programs argue "that students get bogged down taking multiple remedial courses, leading many to give up and drop out. Remedial education, in this view, is a hoax perpetuated upon academically weak students who will be unlikely to graduate" (Attewell, Lavin, Domina, & Levey, 2006, p. 887). Because of the high percentage of placement into remedial mathematics courses at City College, it is of great concern to the researcher that the placement test may unfairly place students into remedial coursework. Without disregarding how ill-prepared high school graduates are for college-level work, college placement is also relevant when you consider that many of the students who take the placement test do so without any preparation – as many

students are forced to take the examination on the same day that they come to register for classes.

Literature supports this concern as Armstrong (2000) revealed that predictive validity studies conducted in community colleges have yielded low correlation coefficients between placement test scores and final grades in remedial courses. He sought to find correlations between placement test scores and final grades in remedial English and mathematics courses. The results of the study determined that while there was a statistically significant relationship between placement test scores and remedial course grades, the relationship was too low to be practically meaningful. He further found that student characteristics affected remedial course grades. "Of particular value were data indicating the student's previous performance in school, such as high school GPA, grade in last English or mathematics course, and number of years of English or mathematics taken in high school" (Armstrong, 2000, p. 688). Furthering the assertion that placement tests alone are not the only valid predictors of remedial placement, Marwick (2004) concluded that a combination of several factors (to include various combinations of high school preparation, years of high school mathematics, and placement test scores) provides a more successful placement policy than consideration of test scores alone. The results also showed that "by using a placement method that considered multiple measures placed [students] into higher-level courses where they achieved outcomes that were equal to or better than the outcomes of students placed by either test score or high school preparation [alone]" (Marwick, 2004, p. 275). Ruiz (2007) also contributes to defining a problem with traditional placement methods by identifying an "error-rate" that accounts for the portion of students who are incorrectly

placed into remedial courses despite having the skills to be successful in college-level courses. Brown (1999) estimates this error-rate at 6 to 8%.

Weber (1985) states "content-specific placement tests in combination with other student data will yield effective assessment forming a basis for placement decisions" (p. 28). He further states that performance on general achievement tests should not be the sole determinant of student placement. Wattenbarger and McLeod (1989) similarly suggested that standardized entrance examinations fail to provide information of sufficient accuracy to justify placement into the mathematics curriculum based solely on the math portion of the test. Additionally, a qualitative study conducted in 2010 suggests that "community college students enrolled in developmental math courses believe they were capable of more advanced work that their developmental math course placement indicated" (Magee, 2010, p. xii).

Hughes and Scott-Clayton (2011) also found that although students are assigned to remediation on the basis of assessment, remediation is not clearly improving outcomes. "This calls into question not only the effectiveness of remedial instruction but also the entire process by which students are assigned to remediation" (p. 2). Hughes and Scott-Clayton also found that the placement tests most commonly used in community colleges (ACUPLACER and COMPASS) "may be reasonably good at predicting whether students are likely to do well in college-level coursework" (p. 19); however, better outcomes do not seem to result for students who are assigned to remediation on the basis of these placement assessments.

To justify the use of a student's high school mathematics preparation in making placement decisions, the National Council of Teachers of Mathematics (NCTM) has established the recommended standards of two algebra courses and one geometry course that Illinois has identified as being college preparatory courses (Marwick, 2004; National Council of Teachers of Mathematics, 2000). The developmental math curriculum is designed to replicate the college preparatory high school curriculum (Marwick, 2004; Illinois Mathematics Association of Community Colleges/Illinois Section of the Mathematics Association of America Joint Task Force, 2008). "Therefore, students' high school mathematics preparation may be a meaningful indicator of what students' first community college mathematics class should be" (Marwick, 2004, p. 268).

Purpose of the Study

This research will analyze student placement in remedial math. More specifically, the purpose of this study is to examine whether a student's cumulative high school GPA or their mathematics grade average are a significant determinant of their performance in the remedial math sequence – as referenced by successful completion of the common midterm and final examinations (the same midterm and final examination is administered for every section of math 098 and math 099 respectively).

The results of this study may be useful in helping City College to change its policies regarding the placement test with the goal of guiding the college in making better placement decisions. The study may also help the college reconstruct its approach to the remedial math curriculum and to address and support student needs more effectively. Furthermore, this study adds to a growing body of research regarding remedial education

as educators seek to improve the outcomes of remediation without sacrificing student access or educational quality. In this regard, this study may also help community colleges (with student demographics similar to those of City College) to evaluate their remedial placement policies and adopt practices that are more likely to encourage student success.

Research Question

The study will address three research questions:

1. Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?
2. Do students who have a higher high school mathematics grade average perform better on periodic course examinations in their remedial math courses?
3. Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?

These questions lead to the following hypotheses that will be tested in this study.

Research Question 1: Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?

Hypothesis 1 – There is a statistically significant difference in periodic assessment scores between students with a higher cumulative high school GPA and students with a

low cumulative GPA; whereby, students who perform better on the periodic assessments tend to have a higher cumulative high school GPA.

Research Question 2: Do students who have higher high school mathematics grade average perform better on periodic course examinations in their remedial math courses?

Hypothesis 2 – There is a significant difference in periodic assessment scores between students with a higher high school mathematics GPA and students with a low high school mathematics GPA; whereby, students who perform better on the periodic assessments tend to have a higher high school mathematics GPA.

Research Question 3: Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?

Hypothesis 3a – There is a statistically significant association between the variables of (a) student's remedial course midterm examination score, and (b) the number of high school math courses completed.

Hypothesis 3b – There is a statistically significant association between the variables of (a) student's remedial course final examination score, and (b) the number of high school math courses completed.

Based on the literature, theory, and findings from Armstrong's (2000) study, analysts who conduct predictive validity studies should expect to find low correlation coefficients between placement tests and remedial course outcomes. It should be noted

that Armstrong's research sought to determine predictive validity between placement test scores and final grades or course retention. Armstrong acknowledged the limitations associated with observing final grade or course retention data by including observations of student characteristics and teacher characteristics as independent variables and course performance as the dependent variable. This research will take a different approach to addressing limitations by using a common midterm and final examination (used for all remedial mathematics courses at City College) which will limit some of the variance in teacher characteristics.

Definition of the Terms

For this study the following definitions were used.

Open Admission: An admissions standard that gives no consideration to a student's academic history. Admission to institutions with open admission policies is non-selective and non-competitive. These institutions generally require a high school diploma or a General Education Development (GED) certificate as the only standard for admission to the institution.

Remedial courses: courses that are developed to help students overcome academic deficiencies. These courses are most often numbered below the 100-level and will not transfer to a four-year institution.

College-level courses: Courses that are numbered above 100-level. Most college-level courses will transfer to a baccalaureate degree granting institution. However, some math courses may not satisfy the baccalaureate degree requirements; therefore, will transfer only as an elective.

Placement examination/testing: An assessment tool that attempts to measure human abilities prior to a course of instruction so that individuals can be appropriately placed, diagnosed, certified, included or excluded (Brown, 1999).

Mathematics Grade Average: The grade point average for mathematics courses taken in high school.

Higher High School GPA: The unweighted high school grade point average.

Predictive Validity: An indication of how well performance on a criterion measure – in this case, remedial mathematics midterm and final exam scores – is predicted by performance on a screening measure – in this case, high school and mathematics performance or grade averages (Hosp, Hosp, & Dole, 2011). Predictive validity is most frequently measured through determining correlation coefficients (Hughes & Scott-Clayton, 2011). While it is not the intention of this research to determine if GPA can predict remedial performance, the researcher does plan to examine correlations to determine if the potential for prediction exists between GPA and remedial performance.

Chapter Summary

During this period of greater accountability in the outcomes provided by community colleges and general economic uncertainty characterized by the highest unemployment levels since the great depression, access to education remains an important concern. As articulated by President Obama as he launched his $12 billion community college initiative, community colleges have been identified as keys to moving our country from economic uncertainty to economic prosperity through the provision of

workforce preparation, training and baccalaureate transfer programs (Kellog & Tomsho, 2009). However, to access these programs students must demonstrate their readiness for college-level work through their performance on placement tests. Many people have expressed their concern regarding the predictive validity of placement tests as well as the social impacts of placement (or misplacement) on the students and their communities.

City College is a community college within an urban city located in the Midwest section of the United States. During the 2009-2010 academic year, 100% of the students tested by the college's placement examination (COMPASS) were deemed in need of mathematics remediation. While this is an astonishing statement, the mathematics placement percentage at City College is reflective of a national trend as a recent study conducted by Achieving the Dream shows that 61% of all entering students are assigned to their institution's lowest level developmental mathematics course (Bailey, 2008). It is the high placement into remedial courses at City College and the concerns for both equality and quality in education that drives this research.

Predictive validity studies support the concerns for equity in education as studies have mostly yielded low correlations between placement test scores and final grades in remedial courses. In these studies researchers found that student characteristics had a greater effect on student performance in college such as high school GPA, grade in last English or mathematics course, and the number of years of English or mathematics taken in high school (Armstrong, 2000). It has also been suggested that placement tests alone are insufficient to ensure accurate placement of students into their appropriate mathematics or English courses (Weber, 1985; Armstrong, 2000; Marwick, 2004).

This study will seek to determine the predictive validity of the student characteristics overall high school GPA and mathematics GPA relative to the students performance on the common midterm and final examinations used in City College's two remedial mathematics courses (Math 098 and 099). The dependent variables midterm and final examination performance were chosen as an attempt to mitigate some of the concern regarding the faculty's subjectivity and variation in the awarding of a final grade.

Chapter II of this dissertation is a review of the relevant literature regarding the case for remedial education; the history of remedial education; placement tests, GPAs and remedial placement; the cost of remedial education programs; remedial education policies; the effectiveness of remedial programs; and, affective concerns for remedial students. Chapter III describes the quantitative approach to answering the three research questions. Chapter IV provides outcomes from the data analysis. Chapter V includes a summary of the research, describes conclusions, and provides recommendations regarding the placement testing policies at City College, implications and recommendations for additional research.

Chapter II

Review of the Literature

Introduction

Remedial education is primarily concerned with helping academically under-prepared students gain and learn the necessary skills needed for them to successfully complete their college education and ultimately obtain gainful employment (Bettinger & Long, 2005). While helping underprepared students, it is noteworthy that remedial education is also beneficial to the institutions that offer these courses (Berg, 2002). By providing remediation, colleges are more accessible to students, thereby increasing the number of admitted students. Additionally, colleges can maintain selectivity in their admission process through separating better prepared students from those who need remediation, which serves to ensure that those who are admitted to college courses will be most likely to complete their chosen program (Bettinger & Long, 2008). As it is implied in the statements above, the extremes in the arguments regarding remedial education generally focus on concerns for equity (access) or excellence (quality).

In order to respond to the academic deficiencies of under prepared students, higher education institutions with open door policies developed a program that would help prepare students for the demands of college courses. The program was similar to the college preparatory classes in the early 1900s where students must first complete the required basic subjects before they endeavored in courses that would build towards a degree. However, different from remedial programs of today, the main objective of college preparatory classes was to help students acquire the needed competencies and

skills that would increase their chances of successfully completing college (Hoyt & Sorensen, 2001). What is commonly known as remedial courses today have gone by many names in the past to include developmental studies, learning assistance, academic skills courses, and developmental courses. Remedial is term that implies a greater concern with correcting (or remedying) academic weaknesses and teaching skills that are required in college courses such as composition writing, communication skills, and basic math skills (Stevenson, Schiller, & Schneider, 1994). The inclination to focus on remediation is based on the knowledge that some students come to college under-prepared for college-level coursework. However, being under-prepared does not mean that the students are unprepared. Therefore, remedial courses are usually designed as basic courses that can adequately prepare students within a term or semester (Walker & Plata, 2000).

While remedial courses have become commonplace in community colleges, the effectiveness of remedial programs has generally not been evaluated. Very few colleges assess student learning in remedial coursework or track students' progress toward degree completion. As research on the effectiveness of remedial programs is lacking there are many reasons that make this concern difficult to examine such as: a lack of consensus among higher education institutions regarding the indicators of an effective remedial program; and, college remedial programs often differ in the number of courses offered, the teaching methods, and course content which also increases the difficulty in measuring the outcomes of the remedial process (Bettinger & Long, 2005). While there has been evidence that suggests that students who enroll in remedial courses are less likely to persist into their second year, it has also been cited that pre-existing conditions may

contribute to the lack of success that remedial students experience (Bettinger & Long, 2005; Brown, 1999).

Perceptions about the value of remedial programs also vary. The public generally believes that remedial education allows greater access to higher education and therefore increases the chances of marginalized and minority students in obtaining a college degree (Hoyt & Sorensen, 2001). Critics of remedial education argue that too much focus on remediation weakens the K-12 education system as it removes the responsibility of preparing students for college from secondary schools. Moreover, giving academically under-prepared students a false hope that they are able to endeavor in college-level work is a waste of resources – since remedial programs have not actually demonstrated an increase in student knowledge and skills (Venezia, Kirst, & Antonio, 2003).

This literature review will present in greater depth many of the themes offered in the introduction above to include the case for and the history of remedial education, placement testing, the cost of remediation, policies for remedial education (both globally and locally), the effectiveness of remedial programs, and affective concerns for remedial students.

The Case for Remedial Education

It has been estimated that only 70% of all students in public high schools graduate. However, only 32% of all students leave high school prepared for college-level work. Moreover, only 51% of all Black students and 52% of all Hispanic students graduate with only 20% and 16% respectively who are prepared for college-level work (Green & Forster, 2003). With specific regard to mathematics readiness, ACT data

shows that only 23% of the 12th grade students who took the ACT test nationally were prepared for college algebra (Sawyer, 2008). In their study, Green and Forster (2003) continue by observing that due to the lower college readiness rates of Black and Hispanic students, they are severely underrepresented in the pool of minimally qualified college applicants. Only 9% of college graduates are Black and another 9% are Hispanic, compared to a total population of 18 year olds that is 14% Black and 17% Hispanic. The National Center for Educational Statistics (NCES) (2003) reported that in the fall of 2000, 42% of new students at public 2 year colleges enrolled in at least one remedial reading, writing, or mathematics course. An increase in the enrollment of remedial courses support Greene and Forster's assertions that more students fail to meet the required skill level for college work. Our nation is in a college readiness crisis.

> Too few of our students are prepared to enter the workforce or postsecondary education without additional training or remediation when they graduate from high school. [Furthermore], far too many [students] have to take remedial courses as a part of their post secondary educations. As a consequence, first-year students are dropping out of school in alarming numbers: one in four freshmen at four-year institutions and one in two freshmen at two-year institutions fails to return for a sophomore year. (ACT, 2005, p. 22)

While we understand that college readiness is a problem, the question remains, what is the answer? The Center for Naval Analyses in cooperation with the Department of Education, Office of Vocational and Adult Education created a literature review that sought to survey the effectiveness of the teaching techniques often touted as being

effective in addressing the needs of remedial mathematics students. The methods that were discussed include: greater use of technology; integration of classroom and laboratory instruction; giving students the option to select from among different instructional methods; use of multiple approaches to problem solving; project-based learning; low student to faculty ratios; assessment and placement of students into the appropriate mathematics courses; and integration of counseling, staff training, and professional development. Although commonly identified as best practices, the researchers failed to identify existing studies that contain scientifically based evidence of the success of any of the aforementioned methods (Golfin, Jordan, Hull, & Ruffin, 2005).

In their research, Golfin, Jordan, Hull, & Ruffin (2005) identified placement into the appropriate mathematics course as an untested solution. Yet, later in the research they identify the use and misuse of placement tests as central to their research by citing studies that suggest that mandatory student assessment and placement tests have a positive impact on student performance (Young, 2002; Boylan & Saxon, 2002). Fewer than 10% of students who require remediation will be successful in college without getting it – only the most motivated students will enroll in remedial courses when placement into remedial courses is voluntary. Therefore, assessment and placement should be mandatory. However, "if unmotivated students are not seeking remediation, making remediation mandatory will not necessarily increase their motivation level or course performance" (Golfin, Jordan, Hull, & Ruffin, 2005, p. 19).

As noted above, college success has been found to be closely linked to the kind of academic preparation that a student has received prior to college. Literature on the relationship of high school grades and college performance is abundant and results often

suggest that a student's high school grades are associated with higher college completion rates and better academic performance in college (Adelman, 1999). However, those findings were only true for students who displayed high academic performance in high school, while the majority of high school graduates do not possess the skills required for college work (Green & Forster, 2003).

College remedial courses are rather extensive; each subject area has approximately two or three courses. Many students complete their remedial coursework; however, as stated earlier, the significance of course completion to later academic performance has proven inconclusive (Merisotis & Phipps, 2000). Taking remedial courses may help students gain needed skills and competencies, but whether it is related to an increase in college completion rates or higher college GPA has not been researched extensively. The lack of research regarding the effectiveness of remediation coursework in terms of student outcomes may be a result of the difficulties that researchers have in studying the effects of such programs. These difficulties include longevity, student persistence (or lack thereof), and faculty attrition (Calcagno & Long, 2008). While there are studies that have overcome these obstacles they have mostly demonstrated conflicting and inconclusive results. Moreover, very few colleges conduct an evaluation of the effectiveness of remedial programs – although some colleges have assessed the post-remedial skills of the students after they have taken remedial courses (Hoyt & Sorensen, 2001).

History of Remedial Education

Community colleges have accepted the responsibility to provide remedial courses to underprepared high school graduates who enroll in college. Remedial courses aim to provide underprepared students with the skills and knowledge that will prepare them for college work (Horn, Cataldi, & Sikora, 2005; Bettinger & Long, 2005). Providing remediation or helping students to attain the needed skill level in college and university is not a recent development. Tutors existed in the 17th century. Their purpose was to augment the competency level of students in different subjects (Institute for Higher Education Policy, 1998). Dating back to the 17th century, the earliest American colleges provided tutors in Greek and Latin for those underprepared students who did not want to study for the ministry. The middle of the 18th century saw the establishment of land-grant colleges – developed to teach agricultural and mechanical courses, which instituted preparatory programs or departments for students who were weak in reading, writing and arithmetic (Payne & Lyman, 1998; Merisotis & Phipps, 2000). Towards the end of the 19th century, as colleges and universities began to compete for students, students were admitted to colleges and universities not fully prepared for the rigor of college. It was estimated that during the late-1800s more than 40% of the first-year college students participated in pre-collegiate programs (Kilian, 2009; Ignash, 1997). Within the 20th century, the percentage of first-year college students participating in pre-collegiate programs continued to increase and enrollments increased. In fact, "over half of the students enrolled in Harvard, Princeton, Yale, and Columbia did not meet entrance requirements and therefore were placed in remedial courses" (Phipps, 1998, p. 3).

With the provisions of open admission in community colleges in the United States, the number of students needing remediation has dramatically increased through the 20th century (Breneman & Haarlow, 1998; Institute for Higher Education Policy, 1998). According to a NCES report on remediation programs in colleges and universities (1996), it is noted that all two-year colleges offered remedial courses. This was done to accommodate students with varying levels of academic preparation from different socioeconomic, cultural and educational backgrounds (Burkam & Lee, 1997).

One might argue that the history that has been described above places its interest in developmental education rather than remedial education. This distinction is important and is accounted for in present literature. Remediation, as defined by Breneman and Haarlow (1998), "means to re-teach, with no reference to other concerns, such as pedagogy. Remediation is distinguished from developmental education by the latter's concern for how to teach students – or why they need such teaching" (p. 9). To that end, developmental courses are more likely than remedial courses to emphasize student work groups, greater student verbal participation, greater student choice, more student responsibility, more visual aids, and other effective pedagogical (or in the case of community colleges, androgogical) methodologies. Brenaman & Haarlow continue by noting that the distinction in terminology is somewhat obfuscating as "by necessity, remedial education also concerns itself with pedagogy, student learning styles, and student development theory" (p. 9). The spirit of the distinction between the two words is provided Cross's "Accent on Learning" where she states:

> A more useful distinction [between remedial and developmental education] is to be found in the purpose of the program. If the purpose of

> the programs is to overcome academic deficiencies, I would term the program remedial, in the standard dictionary sense in which remediation is concerned with correcting weakness. If however, the purpose of the programs is to develop the diverse talents of students, whether academic or not, I would term the program developmental. (Cross, 1976, p. 31)

In considering this distinction, this research will use the term remediation to describe the purpose of pre-college courses.

Placement Tests, GPAs and Remedial Placement

The use of placement tests to identify students needing remediation has been a customary and accepted practice among community colleges and universities. Golfin, Jordan, Hull & Ruffin (2005) focus on placement tests as a means for understanding test content and cutoff scores to bypass developmental mathematics and help create curriculum guidelines for enhancing college preparatory programs; specifically, focusing on placement tests "may provide useful information not only about what students should know but what level of comprehension is required" (p. 19).

The validity of placement tests is of particular concern. Predictive validity is most frequently measured through determining correlation coefficients, where a coefficient of zero indicates no relationship between the test and the relevant outcome and coefficient of one indicates perfect predictive power (Hughes & Scott-Clayton, 2011). A study performed by Armstrong (2000) used correlation coefficients to determine that placement test scores yielded a low correlation with remedial course outcomes. However, correlations coefficients between mathematics test scores and grades in remedial

mathematics are generally computed for those students who place into remedial mathematics.

> Even if the test identifies the students most likely to succeed, this restriction of the range of variation may decrease the correlation coefficients; moreover, there is no obvious or absolute standard for how large a correlation coefficient should be to be considered sufficiently predictive. (Hughes & Scott-Clayton, 2011, p. 13)

Furthermore, ACT, Inc. (2006) has examined placement accuracy rates for its COMPASS test. Using a definition of success as earning a C or higher in the target course, placement accuracy rates range from 63% to 72%.

Hoyt and Sorensen (2001) conducted a study that examined the college English and mathematics placements of high school students based on the courses that they took in high school and the grades that they achieved in those courses. In the study, the researchers surveyed senior students from five high schools among two school districts during the academic years 1995 through 1997. As expected, student preparation in high school mathematics and English courses affected their ACT scores. "As students completed higher levels of English and math in high school, their ACT test scores increased" (p. 27). At the time of the study Utah State Valley College (the school at which approximately 25% of the students selected in the sample attended) required an ACT math cut score of 24 for placement into college algebra. The reported median cut score used by colleges and universities across the country for placement into college algebra is 23. Using this cut score, ACT data shows that only 35% of the students who

took the ACT test nationally were prepared for college algebra. However, as identified in Hoyt and Sorensen's study, students with preparation in algebra 2, intermediate algebra, and geometry in high school had an average ACT math score of 20 for the first district and 19 for the second district (Hoyt & Sorensen, 2001). These students – based on Utah Valley State College's ACT math cut scores – would not be admitted to college algebra and would likely need to repeat in college the same level of math that they took in high school (or in some instances a lower level). In Hoyt and Sorensen's study "90% of the students who earned a C- or better in algebra 2, intermediate algebra, and geometry needed to repeat intermediate algebra or take a remedial math course in college" (Hoyt & Sorensen, 2001, p. 28).

Hoyt and Sorensen's findings are supported by Bettinger and Long (2005) in their study regarding the effects of remediation on college students. In their review of a 2002 study by the Ohio Board of Regents, they found that students who had completed an academic core curriculum in high school were half as likely to need remediation in college as the students who had not completed the academic core curriculum. Using their own data source, Bettinger and Long found that students in math remediation reported lower high school GPAs in math, had taken fewer courses of high school math, and scored lower on both the overall ACT and the math portion. However, the problem remains that there are very few students who take a full battery of college-preparatory math courses.

The correlation between the mathematics courses that a student takes in high school and mathematics achievement test scores was further supported by Jones, Davenport, Bryson, Bekhuis, and Zwick (1986) where the authors find that there is a

convincing relationship between mathematics skill and the number of mathematics courses that a student takes in high school. Correlations for the number of advanced high school mathematics courses (defined as algebra I or higher) that a student took – as reported on the student's transcript – ranged from .62 to .79. Furthermore, the relationship between these variables remained substantial even when adjusted for the students' race and other background characteristics.

The NCES 2003 statistical analysis report indicates that 57 to 61% of colleges and universities gave placement tests to all entering students as an approach to select students for remedial coursework. Despite research that positively correlates high school coursework with college placement, high school grades or coursework are often not given weight as an objective criterion in the admission and placement process since different high schools have different grading systems. Some colleges rely on standardized tests such as the ACT, SAT, ACCUPLACER and the like while others develop their own placement tests (Dixon, Gribbons, & Meuschke, 2002). Community colleges generally do not require the ACT or SAT for entrance to the institution. Rather, admission is most often open to all those with either a high school degree or GED. While community colleges generally do not require the ACT or SAT, some will accept scores from either of these tests in lieu of the institutions required test to determine course placement. Three tests that are most widely used and have been developed to assess basic skills are the Assessment of Skills for Successful Entry and Transfer (ASSET) and the Computerized Adaptive Placement Assessment and Support System (COMPASS), both of which are published by ACT. The third test is ACCUPLACER which is published by the College

Board. A less commonly used test is the Test of Adult Basic Education (TABE) which is produced by CTB McGraw Hill (Golfin, Jordan, Hull, & Ruffin, 2005).

Cost of Remedial Education Programs

Remedial courses often do not earn credits towards degree completion. Therefore these courses are financially costly and restrict the students' ability to enroll in college courses (Finkelstein, 2002). It has been further stated that remedial courses may help in enhancing the skills of students and may contribute to the success of students in college. However, costs associated with remediation may hinder students completing a college degree. Remedial courses absorb a student's time, effort, and money. They take away valuable time from actual college courses and extend the student's college matriculation. Thus, college completion rates may decrease. Conversely, there will likely be an increase in students taking more than four years to complete a bachelor's degree (Venezia, Kirst, & Antonio, 2003). While not directly associated with cost, Bettinger and Long (2008) report other negative impacts of grouping students into remedial courses by referring to this practice as a kind of tracking that is often experienced in primary and secondary schools. They further state that grouping these "lower-ability" students in remedial courses may produce negative effects resulting from the stigma associated with remediation such that the psychological burden could negatively affect outcomes and student motivation – thereby leading to lower completion rates.

In addition to being costly for the student, remediation programs are also costly for the colleges and government agencies that support them. In their 50 state study regarding the cost of remedial education, Breneman and Haarlow (1998) estimate that

remediation absorbs approximately $1 billion annually on a public higher education budget of approximately $115 billion. This equates to less than 1% of expenditures. Through their survey, they also reported that the state of Illinois defined the cost of remediation as direct faculty costs which totaled $27 million in FY 1996. This cost represented 1.1% of the university direct faculty salary budget, and 6.5% of the community college direct faculty salary budget. They also report that these percentages were 0.6% and 5.1%, respectively, in 1980. Breneman and Haarlow assert that 1% of the national higher education budget is a significant number, but represents a very small price to pay for providing remedial education to the approximately 30% of high school graduates who will take remedial courses. "[These expenditures] represent a reasonable public investment of funds if the alternative were to deny access to higher education to students requiring remedial work" (p. 2). Breneman and Haarlow later state:

> It is arguably the lesser of several undesirable outcomes for these student. Compared to other options such as dead end jobs, unemployment, welfare, or criminal activity, together with the social costs that accompany these paths, remediation is surely a good investment. (Breneman & Haarlow, 1998, p. 20)

Laurence Steinberg wrote a commentary to the Breneman and Haarlow (1998) report where he states a belief that 1% of the total budget is a gross underestimation of the total cost for remediation. Stienberg believes that the cost estimate provided by Breneman and Haarlow in no way captures the full cost of remediation because, "It is quite clear that the typical college curriculum has been 'dumbed down' so that many courses which twenty years ago would have qualified for the remedial label are now

offered as bone fide academic courses" (Breneman & Haarlow, 1998, p. 47). Steinberg then cites an example from the university at which he teaches where an additional course was added to the curriculum to accommodate student math/statistics deficiencies. He further states that the practice of underestimating the extent and cost of remediation has many beneficiaries to include: State educators who profit from it because the weak performance of their elementary and secondary school systems remain partially hidden; secondary school administrators who get to pass the cost of teaching basic skills on to post-secondary administrators; post-secondary administrators who can fill their dormitories and classrooms with warm bodies; college students who can get course credit for classes that, if labeled remedial, would not count toward graduation; and remedial education instructors who get to keep their jobs. From a political and economic perspective, there are few constituencies with a stake in providing accurate data on the prevalence of remediation, and many with considerable incentives to understate the extent of the phenomenon (Breneman & Haarlow, 1998).

Businesses are also involved in the remediation of basic skills. "Companies spend an average of 1.8% of payroll on training. Of this amount, 5 to 7% is in basic skills, including literacy, reading, comprehension, writing, math, [English as a second language], and learning how to learn" (Golfin, Jordan, Hull, & Ruffin, 2005, p. 57).

There is also a prevailing argument by many legislators and decision makers that our public schools should prepare students for college and that tax payers should not have to pay twice for the same education. According to the NCES (1996), approximately half of the students graduating from high school in 1994 took a complete battery of college preparatory courses. This means that approximately half of high school graduates did not

take the entire curriculum judged by educators to be a prerequisite for college entry (Boylan, 1999).

Despite whether the cost is 1% of public higher education budgets or greater (as asserted by Steinberg), the billions of dollars spent on remediation have motivated state governments, higher-education institutions, and other policy makers to develop new ways of providing effective and less costly strategies to address remediation needs. Through the College Career Readiness Act (of 2007), the state of Illinois is looking to provide a long-term solution to the problems of remediation, such as the alignment of high school curriculum and college-level skills. Once high school exit competencies are aligned with college entrance standards, there will less need for remediation (Baber, Barrientos, Bragg, Castro, & Khan, 2009).

Remedial Education Policies

Policies on remediation vary across the country. States generally pay for the costs of remediation and provide the guidelines on how and where remediation should be delivered. State policies on remediation change in accordance with the changing educational needs and realities of the institutions they govern. For example, in 1995 most states prescribed that only one-third of higher education institutions in their jurisdictions should provide remedial courses. In some states, remedial courses are restricted in public colleges and universities (Breneman & Haarlow, 1998).

The refusal to provide remediation among state universities is based on the premise that students should have been prepared to deal with college-level work in high school. It was elucidated by Former Mayor Rudolph Giuliani (New York, New York)

that universities should not bear the burden and the costs of teaching students skills that they should have learned in high school (Schmidt, 1998; Breneman & Haarlow, 1998; Bettinger & Long, 2005). In an effort to hold K-12 districts more accountable for the quality of their graduates, some universities have passed the responsibility of remediation to the respective high schools of admitted students who are in need of remedial coursework (McCabe, 2001). However, this has been short-lived as many state policies dictate that remediation should be the responsibility of community colleges. At the present, more and more states are mandating that remedial programs should only be offered in two-year community colleges; and therefore, remedial programs should be banned from four-year colleges. Additionally, many of the colleges and universities who do not offer remedial programs have passed the responsibility of teaching remedial courses to private institutions and learning centers (Phillippe & Sullivan, 2005).

In order to regulate remedial courses and make sure that they do not lengthen the time it takes for a student to matriculate through college, some universities have placed limits on the amount of time that students have to complete remedial coursework. For example, California State University only allows one year for its students to complete their remedial coursework. Failure to complete the remedial courses result in the student being refused admission to college-level courses (Kirst & Venezia, 2001). On the other hand, to deter students from being placed in remedial courses, students are asked to pay the costs of remedial courses in Florida which are often more expensive than college-level courses (McCabe, 2001).

Although limited to only six states (California, Florida, Illinois, New York, Texas, and Washington), Perin (2006) found that:

1. Five of the six states mandated entrance assessments, and in the state that did not, the individual institutions mandated entrance assessments;

2. A variety of entrance assessment instruments were used, and in three states the instrument was determined by state policy;

3. Of the three states (that maintained state policies regarding the specific entrance assessment that should be used), two determined the cut scores to be used;

4. Remedial placement was required in only four of the six states; and

5. Only one state (California) has a policy regarding the length of time that a student can take remedial coursework (Hughes & Scott-Clayton, 2011).

In the state of Illinois, the General Assembly (as early as 1979) decreed that community colleges be designated as the main provider of remedial education for under-prepared students entering college. Additionally, the Illinois Board of Higher Education reiterated that it is also the responsibility of the colleges and universities to provide remedial education to current students and other support services that would aid in maximizing student's access to higher education (Baber, Barrientos, Bragg, Castro, & Khan, 2009). Community colleges in the state of Illinois have designed and offered remedial courses that are able to aid students in remedying academic deficiencies that have been identified by placement tests.

Effectiveness of Remedial Programs

Most educators, students and parents share a concern regarding the prevalence of remedial education in higher education. Despite the growing trend of underprepared students, and the increased need for remedial courses little information about the effects of remediation to the academic performance of students had been reported. The lack of information had been due to the lack of concrete measures of the student outcomes of remedial education. The few researchers that examined the effects of remedial education to the academic performance of students reported that not many colleges and universities have programs that assessed the effectiveness of their own remedial programs (Bettinger & Long, 2005; Boylan, 1999; Golfin, Jordan, Hull, & Ruffin, 2005; Hoyt & Sorensen, 2001; Weissman, Bulakowski, & Jumisko, 1997). Many institutions do not track the progress of the students after they complete remedial coursework. Reported graduation and drop-out rates do not classify whether the student was on remedial courses or not. At the same time, colleges and universities do not have policies for testing entry and exit skills of remedial students and there are no clear standards from which to base skills improvement or mastery. A 1994 study of 116 two- and four-year institutions revealed that only a small percentage conducted any systematic evaluation of their developmental education programs. All of these factors made evaluating remedial programs difficult and methodologically weak (Weissman, Bulakowski, & Jumisko, 1997).

Although studies relative to the success of remedial or developmental programs are difficult to ascertain, since the mid-90s there have been studies conducted that evaluate the success of remedial students. In their study, Bettinger and Long (2005) found that community college students who have completed a remedial program perform

on par with similar students who were not enrolled in remedial courses relative to completion or transfer to a four-year institution. In fact, their study cites that students who were placed in math remediation were found to be 15% more likely to transfer to a four-year college than students with similar test scores and high school preparation who attended colleges with policies that did not require placement into remedial courses. They also found that participation in remedial math courses does not appear to affect a student's persistence in college, or their likelihood of completing a degree program.

Three years later, Calcagno and Long (2008) conducted a study of nearly 100,000 college students in Florida to determine the impact of remedial education to persistence of students (both long- and short-term persistence). They tracked the movement of remedial students from remedial courses through degree completion. Calcagno and Long found that remedial education has mixed benefits. They found that students in remedial courses were more likely to continue to their second year in the college. However, there was no evidence that having taken remedial classes increases the completion of college-level credits or eventual degree completion. "The results suggest that remediation might promote early persistence in college, but does not necessarily help students make long-term progress toward earning a degree" (Calcagno & Long, 2008, p. 5).

Affective Concerns for Remedial Students

While much of this literature review has focused on remedial education policies and program features, there is a body of research that expresses concern for the effect of placement into remedial courses on a student's self-efficacy. Earlier in this literature review, the researcher cited Bettinger and Long (2008) who stated that grouping "lower-

ability" students in remedial courses may produce negative effects resulting from the stigma associated with remediation such that the psychological burden could negatively affect outcomes and student motivation – thereby leading to lower completion rates. "Students must feel competent to be competent" (Kilian, 2009, p. 47). They must feel as if they are capable of producing at the levels at which they are placed. If a student enters remedial math believing that they have difficulties learning math, then this may become a self-fulfilling prophecy, thereby, having an immense impact on the student's academic life (Kilian, 2009).

Colleges may also create a student's sense of self-efficacy through the remedial placement policies that are used. Deil-Amen and Rosenbaum (2002) use the term cooling out to describe the "process by which community colleges urge students to recognize their academic deficiencies and lower their aspirations" (p. 250). They further state that cooling out may also be used to describe the ways in which community colleges encourage students to lower their expectations for obtaining bachelor's degrees and to aspire for obtaining one- or two-year degrees in vocational or applied programs.

The community college faculty may also contribute to a student's sense of self-efficacy through the exhibition of low expectations. Some instructors do not expect under-prepared students to achieve and therefore may respond to students' low skill levels by focusing their efforts on a few promising students while largely giving up on the rest (Kilian, 2009; Dougherty, 1994).

The sad irony is that these low expectations feed a self-fulfilling prophecy. In a process well described by labeling theorists within the sociology of

> education, … low expectations tend to lead teachers to withdraw attention and praise from poorer students, which in turn reinforces the very poverty of the student['s] performance. (Dougherty, 1994)

Chapter Summary

Research shows that enrollment in remedial education programs has continued to rise to levels that are making policymakers and educators alike determined to find the solutions that better prepare students for college-level coursework. While that statement implies that our K-12 systems are failing, it is often cited that a solution lies in our ability to align high school exit standards with college entrance standards.

The history of remediation (or developmental education) provides us with a look back into the present as educators contemplated then the same concerns that exist today. Ensuring access to higher education through a program of study that prepares students for the academic rigors of college-level work. While four-year institutions attempt to justify the cost of providing remedial programs, community colleges have become the target for fulfilling the mission of remediation for many students. Today, all community colleges offer remedial programs and/or courses (Burkam & Lee, 1997; National Center for Education Statistics (NCES), 2003).

To identify who should take remedial courses, many colleges rely on placement tests. Cut scores help academic administrators to ascertain the performance level of each student. However, it is important to recognize that placement tests not only provide useful information about what a student should know, but also the level of comprehension is required (Golfin, Jordan, Hull, & Ruffin, 2005). Therefore, in theory

testing is not just about determining a student's future, but as a form of assessment that helps to shape what is taught in high schools to better prepare students. To that end, studies reveal a strong positive correlation between a student's high school preparation (students who take a complete battery of college-preparatory mathematics) and placement in college-level courses. While that strong, positive correlation exists, the problem remains that far too many students do not take all of the needed college preparatory courses.

Also damaging to students and institutions alike are the costs of remediation. For students, remediation extends their college matriculation and is often more costly than regular college credit courses. For the institutions, it is estimated that remediation costs approximately $1 billion annually. However, arguments exist that suggest that the real cost of remediation could be much higher if the curriculum changes that have been made to accommodate students' knowledge gaps and corporate or business investments in improving the basic skills of its workforce are considered.

These costs – combined with concerns regarding the effectiveness of remedial programs – have engaged politicians, policymakers, and educators in attempting to resolve through public policy a remediation problem has been difficult to define. Defining the problem of remediation is difficult because little information regarding its effect on student performance has been reported. Furthermore, institutions have not treated remedial courses like college programs; therefore, assessment data generally does not exist. While program assessment is difficult to find, there are recent studies that use regression analysis and other data manipulation tools to understand the long-term impacts of remedial programs to student persistence and graduation. What has been found is that

remediation may help a student persist in the short-term, but, long-term persistence and degree attainment is not attained.

Chapter III

Methodology

Introduction

The purpose of this research was to analyze student placement in remedial math. Specifically, the purpose of this study was to examine whether a student's cumulative high school GPA or their high school mathematics grade average are a significant determinant of their performance in the remedial math sequence – as referenced by successful completion of the common midterm and final examinations.

Chapter III describes the design and methodology of the study. Included will be the research questions, research design, a description of the participants, the statistical procedures, the research instruments, and the study limitations.

The study will address three research questions:

1. Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?
2. Do students who have a higher high school mathematics grade average perform better on periodic course examinations in their remedial math courses?
3. Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?

Research Method and Design Appropriateness

A non-experimental, quantitative, correlational research design was used for the proposed study. The objective of the quantitative correlational design was to examine potential relationships among variables (Cresswell, 2005; Johnson & Christensen, 2007). The quantitative method was selected to utilize an explanatory correlational design. Explanatory research design consists of determining the extent of association between two (or more) variables (Cresswell, 2005). This type of design was chosen for this study in order to investigate possible associations between the independent variables of high school GPA and high school mathematics GPA with dependent variables of remedial course midterm examination grade and remedial course final examination grade.

A quantitative correlational research design was considered appropriate for the study, since investigation of relationships between variables, including their strength and direction of association, is the motive of this study. According to Cresswell (2005), correlational designs are "procedures in quantitative research in which investigators measure the degree of association or relationship between two or more variables using statistical procedures" (p. 52).

In correlational research, the two primary correlation designs are: explanatory and prediction (Cresswell, 2005). Explanatory correlational research design is defined as "the extent to which two variables (or more) co-vary, that is, where changes in one variable are reflected in changes in the other" (Cresswell, 2005, p. 237). The objective of prediction design is to anticipate outcomes by using certain variables as predictors" (Cresswell, 2005, p. 328). However, the intent of this study was not to make predictions

about outcomes. Rather, the purpose was to show the extent of the relationship between the variables of high school GPA and performance in a remedial mathematics course; therefore, an explanatory design was appropriate.

Quantitative research addresses questions about relationships between measured variables for the purpose of explaining, predicting, and controlling events (Leedy & Ormrod, 2005). The quantitative approach was appropriate because it reduces potential biases by focusing on direct responses with a minimum of interpretation. Quantitative research involves the use of specific and narrow questions targeted toward measuring and explaining variable relationships (Cresswell, 2005).

Qualitative research design was not selected for the proposed study. Qualitative research design is not appropriate for this current study because this process analyzes words or text from participates and inquiries are conducted in a more subjective and biased manner (Cresswell, 2005).

A variety of methods are available to examine differences and relationships between high school GPA and remedial mathematics course performance. A retrospective observational study method was chosen for this study. Other methods include experiments, survey sampling, focus groups, case studies, or interviews (Cresswell, 2005). The dataset used for this study was collected by the researcher from records located at City College. The dataset includes information collected for the fall 2010 semester.

The retrospective data collection from the City College database provided more detailed information than could be collected by survey sampling or with focus groups due

to temporal and cost considerations. Also, use of the City College database allowed for more objective data collection than could be done if collecting more subjective participant answers on surveys or with focus groups. An experimental design was not appropriate to this study due to ethical limitations on the ability to manipulate study groups to achieve desired answers to the questions of this study.

The design of this study is consistent with the design of other studies that evaluate the relationship between high school performance and college placement or placement outcomes in that most have used a quantitative correlational research design. Armstrong (2000) utilized Pearson product-moment correlations of test scores in reading, writing and mathematics with the dependent variable of course grade in responding to the research question, "are placement tests highly predictive of course performance outcomes such as course grades?" (p. 686). Jones, Davenport, Bryson, Bekhuis, & Zwick (1986) utilized an analysis of covariance to examine the relationships between the independent variables number of mathematics courses taken in high school as reported by the student and number of mathematics courses taken in high school as reported on the student's transcript compared to the dependent variable percentage of correct answers on a mathematics entrance assessment. In their analysis they also considered latent effects of a student's prior mathematics performance, their home environment, and general intelligence (as it was considered that brighter students may have a tendency to select more challenging courses). Hoyt and Sorensen (2001) utilized a logistic regression to examine the relationships between the independent variables of a student's level of preparation, grades in mathematics and English, gender, ethnicity, delayed entry into

college and their attendance at different high schools as compared to the dependent variable remedial placement.

Population and Study Sample

This study included records of all students who were enrolled in remedial math courses (Math 098 – Beginning Algebra with Geometry and Math 099 – Intermediate Algebra with Geometry) during the fall 2010 semester at City College. The students in Math 098 were there either as a result of being placed into the course after taking the college's placement test or because they are repeating the course. Similarly, the students in Math 099 were there either as a result of being placed into the course after taking the college's placement test, because they completed Math 098 (and are still unprepared for college-level math), or because they were repeating the course. Records for 339 Math 098 and 242 Math 099 students were available in this study. This sample represents the entire population of students who took these courses (at City College) during the fall 2010 semester. In this regard, the sampling strategy that is being employed is most similar to a convenience sample.

All analyses for this study also required a student to have high school GPA information. Therefore, the sample used in this study included student records that have both a high school GPA and high school mathematics GPA. A total of N = 74 records were obtained that met this inclusion criteria.

Data Collection and Operationalization of Variables

Data was collected from the City College database and included records of students who participated in a remedial math course for the fall 2010 semester and who

also had documented GPA values for high school (overall) and for high school mathematics. Variables were operationalized as follows:

Student's Cumulative High School GPA: The student's grade point average for all courses taken during their high school matriculation. This is a continuous variable with values ranging from 0.0 to 4.0. The sample was sub-divided into two groups for use in independent samples *t-test* analysis as (a) those with a high GPA (2.5 or above), and (b) those with a low GPA (2.49 or below).

High School Mathematics GPA: The average grade received in all mathematics courses taken by the student during their high school matriculation. This is a continuous variable with values ranging from 0.0 to 4.0. The sample was sub-divided into two groups for use in independent samples *t-test* analysis as (a) those with a high GPA (2.5 or above), and (b) those with a low GPA (2.49 or below).

Midterm Examination Score: The midterm examination score received by the student taking a remedial mathematics course (Math 98 or Math 99). This variable is a continuous variable with a range from 0 to 100.

Final Examination Score: The final examination score received by the student taking a remedial mathematics course (Math 98 or Math 99). This variable is a continuous variable with a range from 0 to 100.

Number of High School Mathematics Courses: The number of mathematics courses taken in high school for each student. A total of 20 different high school mathematics course classifications are represented on this variable. Each class taken by a student counted as one course. The number of courses was then summed for a total

number of high school mathematics classes taken for each student. This variable is ordinal with a possible range from 0 to 20.

Data Analysis

Three research hypotheses were addressed in this study. Prior to hypothesis testing, a Pearson's product moment correlation was performed to assess the relationship of the variables used to address Hypotheses 1 and 2, (a) Student's Cumulative High School GPA, (b) High School Mathematics GPA, (c) Midterm Examination Score, and (d) Final Examination Score. Checks for multicollinearity were performed using the results of the Pearson's correlation.

The research questions, associated statistical hypotheses, and statistical analyses planned for this study were as follows:

Research Question 1: Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?

Hypothesis 1: There is a statistically significant difference in the mean periodic assessment scores between students with a high cumulative high school GPA and students with a low cumulative GPA; whereby, students who perform better on the periodic assessments tend to have a higher cumulative high school GPA.

An independent samples *t-test*s was used to address Hypothesis 1. The independent variable was high school GPA classification, which was grouped into two categories of (a) those students with a high GPA (2.5 or above), and (b) those students with a low GPA (2.49 or below). The dependent variable for the first *t-test* was the

student's midterm examination score. The dependent variable for the second *t-test* was the student's final examination score.

Research Question 2: Do students who have higher high school mathematics grade average perform better on periodic course examinations in their remedial math courses?

Hypothesis 2: There is a significant difference in the mean periodic assessment scores between students with a higher high school mathematics GPA and students with a lower high school mathematics GPA; whereby, students who perform better on the periodic assessments tend to have a higher high school mathematics GPA.

An independent samples *t-test*s was used to address Hypothesis 2. The independent variable was high school mathematics GPA classification, which was grouped into two categories of (a) those students with a high GPA (2.5 or above), and (b) those students with a low GPA (2.49 or below). The dependent variable for the first *t-test* was the student's midterm examination score. The dependent variable for the second *t-test* was the student's final examination score.

In addition to the independent samples *t-test*s that were performed for hypotheses 1 and 2, two multiple regressions were performed for each dependent variable outcome of (a) student's remedial course midterm examination score, and (b) student's remedial course final examination score. The independent predictors for each of the two multiple regressions were (a) high school mathematics GPA, and (b) student's cumulative high school GPA. Including both GPA scores as independent variables in the multiple regression allowed for investigation of the effect of one independent variable on the

dependent variable outcome while controlling for the second independent variable. For instance, one can use multiple regression to control for the influence of high school GPA when investigating the influence of high school mathematics GPA on the dependent variable outcome of remedial course final score.

Research Question 3: Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?

Hypothesis 3a: There is a statistically significant association, or a significant indirect association, between the variables of (a) student's remedial course midterm examination score, and (b) the number of high school math courses completed.

A Spearman's rank order correlation was used to address Hypothesis 3a. The variable of the number of high school math courses completed is ordinal with a range of counts from 0 to 20. The variable of student's remedial course midterm examination score is continuous with a range of possible scores from 0 to 100.

Hypothesis 3b: There is a statistically significant association, or a significant indirect association, between the variables of (a) student's remedial course final examination score, and (b) the number of high school math courses completed.

A Spearman's rank order correlation was used to address Hypothesis 3b. The variable of the number of high school math courses completed is ordinal with a range of counts from 0 to 20. The variable of student's remedial course final examination score is continuous with a range of possible scores from 0 to 100.

Power Analysis and Required Sample Size

This study made use of a series of independent samples *t-test*s and multiple regression analyses that were performed. Two power analyses were performed to determine the required sample size for this study. GPOWER v3.1.2 software was used in this determination. All power analyses were set at a power level of .80. At a power of .80, one has an 80% chance of seeing significance that is truly present in the data.

The power analysis for the independent sample *t-test* was performed with an alpha level of .05, medium effect size of 0.25, and a power of .80 indicated that a total sample size of 102 participants was required to achieve 80% power. The power analysis was then performed with a large effect size of .80 with the resulting required total sample size to achieve 80% power of 42 participants.

The apriori power analysis for the multiple regression was performed with an alpha level of .05, a medium effect size of 0.25, power of .80, and 2 predictors. Results indicated that a total sample size of 68 participants was required to achieve 80% power.

The sample size for this study is N=74 students. Therefore, there was enough data to perform the analyses planned in this study.

Limitations

Possible limitations of this study included the definitions used for inclusion, i.e., the student must have a documented GPA for high school mathematics and cumulative high school performance. In addition, this study was conducted in one community college, thus limiting the scope of the research.

Additionally, this study included the possibility of multiple latent independent and dependent variables which may have affected the results of the study. Possible variables not included for analysis include latent considerations such as the size and socio-economic status of the school populations, and the principals' and teacher's demographics and experience as educators, all of which are factors that may have presented a limitation to this study. Although there are potential limitations and delimitations, this study produced significant findings to the research knowledge base and in regards to placement test procedures and placement decisions. This study may also help the college to more effectively address issues regarding the remedial math curriculum and to address and support student needs more effectively.

Chapter Summary

Chapter III presented the methodologies used for this quantitative correlational study. The discussions of this chapter provided insight on the direction of the study and the choice of methodology. The chapter also included discussions on population, sample, operationalization of variables for analysis, data collection and data analysis, and possible limitations to the study. Chapter IV will present the results of analyses as relates to the methods presented in this chapter.

Chapter IV

Results

Introduction

In chapter IV, the results of this study are presented in a descriptive format and with tables. The results of chapter IV are divided into three sections: (1) population and descriptive findings, (2) investigation of assumptions as related to the inferential analysis, and (3) tests of hypotheses. The chapter concludes with a summary of the results. SPSS v15.0 was used for all descriptive and inferential analyses. All inferential analysis were tested at the 95% level of significance.

The purpose of this correlational quantitative research was to analyze student placement in remedial math. Specifically, the purpose of this study was to examine whether a student's cumulative high school GPA or their mathematics grade average are a significant determinant of their performance in the remedial math sequence – as referenced by successful completion of the common midterm and final examinations.

Population and Measures for Central Tendency

This study included all students who were enrolled in remedial math courses (Math 098 – Beginning Algebra with Geometry and Math 099 – Intermediate Algebra with Geometry) during the Fall 2010 semester at City College. The students in Math 098 were enrolled as either a result of being placed into the course after taking the college's placement examination or because they were repeating the course. Similarly, the students in Math 099 were enrolled either as a result of being placed into the course after taking

the college's placement examination, because they completed Math 098 (and are still unprepared for college-level math), or because they were repeating the course. Records for 339 Math 098 students and 242 Math 099 students were available in this study. This sample represents the entire population of students who took these courses at City College during the fall 2010 semester.

All analysis for this study required a student to have a high school transcript on file in the college's Registrar's Office. Therefore, the sample used in this study included only the student records where a midterm and final grade existed (for the student's respective Math 098 or Math 099 course) and a high school transcript was on file (indicating the high school GPA and listing all mathematics courses taken). A total of $N = 74$ records were obtained that met this inclusion criteria.

Demographic information was not obtained for the study participants. The type of course taken by a participant (Math 098 versus Math 099) and frequency counts of the number of high school mathematics courses taken by a student were obtained. Additionally, each participant's cumulative high school GPA and high school mathematics GPA were obtained. The student GPAs were divided into two groups for use as the independent variable for the independent samples *t-test* of hypotheses 1 and 2. The independent GPA variable was classified as (a) those with a high GPA (2.5 or above), and (b) those with a low GPA (2.49 or below). Table 1 presents the frequency and percentages of the count data used in the study.

Table 1

Frequencies and Percentages of the Classifications of the Count Variables Used in Study (N = 74)

Variable /Classification	Frequency	Percentage
Students enrolled in Math 098	48	65%
Students enrolled in Math 099	26	35%
Number of high school mathematics courses completed		
3	31	42%
4	32	43%
5	10	14%
6	1	2%
GPA classification of cumulative high school coursework	57	77%
Low GPA (2.49 or below)	17	23%
High GPA (2.5 or above)		
GPA classification of high school mathematics coursework	57	77%
Low GPA (2.49 or below)	17	23%
High GPA (2.5 or above)		

The majority of students were enrolled in Math 098 (48 students, 65% of students). Students completed from three to six mathematics courses in high school. Also, the majority of students were classified as having a low GPA for both the cumulative high school coursework and the high school mathematics coursework (57 students, 77% of students).

Table 2 presents measures of central tendency for the continuous variables used in the study. The mean cumulative high school GPA ($M = 2.19$; $SD = 0.54$) and mean high school mathematics GPA ($M = 2.05$; $SD = 0.68$) were close in value. The means of the

remedial course midterm and final scores were both low, *M* = 66.83, *SD* = 20.38 and *M* = 55.66, *SD* = 30.31 respectively.

Table 2

Measures of Central Tendency of Continuous Variables (N = 74)

Variable	*M*	*SD*	*Mdn*	*Range*
Cumulative high school GPA	2.19	0.54	2.10	1.16 – 3.80
High school mathematics GPA	2.05	0.68	1.95	.067 – 4.00
Remedial course midterm exam score	66.83	20.38	70.00	0.00 – 100.00
Remedial course final exam score	55.66	30.31	67.50	0.00 – 100.00

Note. *M* = Mean, *SD* = Standard Deviation, *Mdn* = Median

Inferential Analysis - Assumptions

Five records (6.8%) were missing data on the remedial course midterm examination score. Six records (8.1%) were missing data on the remedial course final examination score. SPSS software gives an option of pairwise deletion of records with missing data. Pairwise deletion is a technique that excludes cases when they are missing data for a particular analysis, but includes the case for all analyses for which they have the needed information (Pallant, 2007). The cases with the missing information on the respective variables were therefore excluded from analyses relating to hypotheses 1 and 2.

The dataset was investigated for the inferential analysis assumptions of absence of outliers, normality, equal variances, linearity and homogeneity of variance as related to the four variables used for hypothesis testing.

Outliers in a dataset have the potential to distort results of an inferential analysis. A check of boxplots for the four continuous variables used during inferential analysis of (a) cumulative high school GPA, (b) high school mathematics GPA, (c) remedial course midterm examination score, and (d) remedial course final examination score, was visually inspected for outliers. The boxplots indicated that none of the variables contained more than 5% outliers. The variables were standardized to check for the presence of extreme outliers (z-score of +/- 3.3). None of the outliers were extreme. Median and mean values were also close in value for each of the four variables, indicating that outliers were not adversely affecting the dataset. Since all outliers were in acceptable ranges of their associated constructs, construct means and medians were similar for each construct, and less than 5% of the data were missing on any construct, it was determined that the outlier assumption was not violated; therefore, all records would be retained for analysis.

Normality for the four continuous variable constructs was investigated with SPSS Explore. The Kolmogorov-Smirnov test for normality indicated normal distribution at the $p = .01$ level on three of the variables, but not for the variable of remedial course final examination score. A visual check of the histogram for the remedial course final examination score variable indicated a left skew. However, the probability plots (Q-Q plots) indicated normality in the remedial course final examination score. Because the requirements for equal variance and absence of outliers, linearity, and homogeneity of variance are met, it was determined that the assumption of normality was not seriously violated and parametric tests were used on all four of the continuous variable constructs during inferential analysis, without transformation.

The assumption of equal variances, a requirement for the *t-test*s of hypothesis 1 and 2, was investigated using Levene's test. The assumption was met for hypothesis 1, but not for hypothesis 2. SPSS gives an adjusted value for independent *t-test* outcomes when the equal variance assumption is violated. These adjusted *t-test* values were used to address hypothesis 2.

Assumptions of linearity between study variables homogeneity of variance, requirements for corelational and regression analysis, were checked with scatterplots of the data. The assumptions of linearity and homogeneity of variance were not violated.

Multicollinearity diagnostics for multiple regression were performed using SPSS. No violations were noted and the assumption of absence of multicollinearity was not violated. Table 3 presents the results of the Pearson's correlational analysis that was performed. Statistically significant findings for bi-variate variable associations included (a) cumulative high school GPA with high school mathematics GPA ($r = .781$, $p < .0005$), (b) cumulative high school GPA with remedial course midterm examination score ($r = .336$, $p = .005$), (c) high school mathematics GPA with remedial course midterm examination score ($r = .337$, $p = .005$), (d) high school mathematics GPA with remedial course final examination score ($r = .336$, $p = .005$), and (e) remedial course midterm examination score with remedial course final examination score ($r = .630$, $p < .0005$). All correlations were positive, indicating that when values increase or decrease on one variable, the values on the associated variable move in a similar direction.

Table 3

Pearson's Product-Moment Coefficients of Inferential Study Variables

Variable		1	2	3
1	Cumulative high school GPA			
2	High school mathematics GPA	.781*		
	Significance (p-value)	.000		
3	Remedial course midterm examination score	.336*	.337*	
	Significance (p-value)	.005	.005	
4	Remedial course final examination score	.226	.336*	.630*
	Significance (p-value)	.064	.005	.000

* *Correlation is significant at the 0.01 level*

Hypothesis Testing

A total of three hypotheses were tested. The results are presented according to each research question and the associated statistical hypothesis.

Research Question 1: Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?

Hypothesis 1: There is a statistically significant difference in the mean periodic assessment scores between students with a higher cumulative high school GPA and students with a lower cumulative GPA; whereby, students who perform better on the periodic assessments tend to have a higher cumulative high school GPA.

A series of two independent samples *t-test*s were performed. Table 4 presents the results of the *t-test* analyses. The first *t-test* analysis was performed to determine whether

there was a difference between students with low cumulative high school GPAs (M = 63.57, SD = 20.64) and students with high cumulative high school GPAs (M = 76.83, SD = 16.32) on the outcome variable, midterm examination score. Upon performing the *t-test* analysis, Levene's Test for Equity of Variances is not significant ($p = .586$). The mean difference reflects that students with high cumulative high school GPAs perform better on midterm examinations than students with low high school GPAs, $t = -2.409$, $df = 67$, $p < .05$. The differences between the groups are significant and valid. Additionally, the mean difference is 13.26.

The second *t-test* analysis was performed to determine whether there was a difference between students with low cumulative high school GPAs (M = 52.88, SD = 30.77) and students with high cumulative high school GPAs (M = 63.97, SD = 28.11) on the outcome variable, final examination score. Table 5 presents the results of the *t-test* analysis that was performed. Upon performing the *t-test* analysis, Levene's Test for Equity of Variances is not significant ($p = .227$). However the analysis reflects that there is not a difference between the groups. Therefore the differences between the mean final examination scores between students with low cumulative high school GPAs and students with high cumulative high school GPAs are not valid, $t = -1.314$, $df = 66$, $p > .05$.

Table 4

Group Statistics for Hypothesis 1

		N	Mean	Std. Deviation	Std. Error Mean
Midterm Exam Score	(low = 2.49-) (high = 2.5+)	52 17	63.57 76.82	20.64 16.32	2.86 3.96
Final Exam Score	(low = 2.49-) (high = 2.5+)	51 17	52.88 63.97	30.77 28.11	4.31 6.82

Independent Samples Test for Hypothesis 1

	Levene's Test for Equity of Variances		t-test for Equity of Means			
	F	Sig.	T	df	Sig. (2-tailed)	Mean Diff.
Midterm Exam Score	.23	.586	-2.41	67	.019	-13.26
Final Exam Score	1.49	.227	1.31	66	.194	-11.09

There is sufficient evidence to indicate a difference in the mean remedial course midterm examination scores between students with low cumulative high school GPAs versus students with high cumulative high school GPAs. Students with a high cumulative high school GPA performed significantly better on the remedial course midterm examination. While the same cannot be stated regarding the final examination, the researcher recognizes that the small sample size may have affected the ability to establish significance in the difference between the means. The researcher rejects the null hypothesis relating to research question 1.

Research Question 2: Do students who have high, high school mathematics grade average perform better on periodic course examinations in their remedial math courses?

Hypothesis 2: There is a significant difference in the mean periodic assessment scores between students with a high, high school mathematics GPA and students with a low high school mathematics GPA; whereby, students who perform better on the periodic assessments tend to have a high, high school mathematics GPA.

A series of two independent samples *t-test*s were performed. Table 5 presents the results of the *t-test* analyses. The first *t-test* analysis was performed to determine whether there was a difference between students with low high school mathematics GPAs (M = 62.36, SD = 20.18) and students with high, high school mathematics GPAs (M = 80.51, SD = 14.25) on the outcome variable, midterm examination score. Upon performing the *t-test* analysis, Levene's Test for Equity of Variances is not significant ($p = .229$). The mean difference reflects that students with high, high school mathematics GPAs perform better on midterm examinations than students with low high school GPAs, $t = -3.431$, $df = 67$, $p < .05$. The differences between the groups are significant and valid. Additionally, the mean difference is 18.15.

The second *t-test* analysis was performed to determine whether there was a difference between students with low high school mathematics GPAs (M = 49.18, SD = 31.65) and students with high, high school mathematics GPAs (M = 75.09, SD = 13.46) on the outcome variable, final examination score. Upon performing the *t-test* analysis, Levene's Test for Equity of Variances is significant ($p = .000$). The mean difference reflects that students with high, high school mathematics GPAs perform better on final examinations than students with low high school GPAs, $t = -4.71$, $df = 61.97$, $p < .0005$. The differences between the groups are significant and valid. Additionally, the mean difference is 25.92.

Table 5

Group Statistics for Hypothesis 2

		N	Mean	Std. Deviation	Std. Error Mean
Midterm Exam Score	(low = 2.49-) (high = 2.5+)	52 17	62.36 80.51	20.18 14.25	2.80 3.46
Final Exam Score	(low = 2.49-) (high = 2.5+)	51 17	49.18 75.09	31.65 13.46	4.43 3.27

Independent Samples Test for Hypothesis 2

	Levene's Test for Equity of Variances		t-test for Equity of Means			
	F	Sig.	T	df	Sig. (2-tailed)	Mean Diff.
Midterm Exam Score	1.48	.229	-3.43	67	.001	-18.15
Final Exam Score	16.89	.000	-4.71	61.97	.000	-25.91

There is sufficient evidence to indicate a difference in both the mean remedial course midterm examination scores and mean remedial course final examination scores between students with low cumulative high school GPAs versus students with high cumulative high school GPAs. Students with a high cumulative high school GPA performed significantly better on the remedial course midterm and final examinations. Therefore the researcher rejects the null hypothesis relating to research question 2.

Multiple Regression Analysis – For Questions 1 and 2.

To further investigate the influence of cumulative high school GPA and high school mathematics GPA on the remedial course midterm and final examination scores, two multiple linear regressions were performed. Including both GPA scores as independent variables in the multiple regression allows for investigation of the effect of one independent variable on the outcome (dependent) variable while controlling for the second independent variable.

The first multiple linear regression was performed using the outcome variable student's remedial course midterm examination score and the two independent predictors cumulative high school GPA and high school mathematics GPA. Results of the regression are presented in Table 3 and include the coefficient for each predictor (*B*), the associated standard errors (*SE B*), standardized regression coefficients (β), the t-statistic, and significance values for the predictor variables.

Table 6

Multiple Regression Results for Midterm Examination Score Regressed on Independent Predictors of Cumulative High School GPA and High School Mathematics GPA (N = 68)

Variable	*B*	*SE B*	*β*	*t*	*Sig.*
Cumulative high school GPA	6.98	6.94	0.19	1.01	.318
High school mathematics GPA	5.77	5.52	0.19	1.05	.299

$F = 4.81$
$R^2 = .127$
Adjusted $R^2 = .101$

Note. Sig. = Significance (p-value).

This multiple regression model (using midterm examination score as the outcome variable) is significant $F\ (2, 66) = 4.81$, $p = .011$, with R^2 of .127 (*Adjusted* $R^2 = .101$) and 95% confidence limits ranging from 0 to .27. The adjusted R-square value of .101 indicates that approximately 10.1% of the variability in the dependent variable of remedial course midterm examination score was predicted by the student's cumulative high school GPA and mathematics GPA. However, neither of the predictors were significant. The significance levels provided for each of the two independent variables indicates whether that particular variable is a significant predictor of the outcome (dependent) variable – holding all other independent variables constant. A possible reason for the lack of significance in the independent variables is that the variance in the outcome variable could be shared by the two predictor variables. Consequently, neither of the independent variables are uniquely predictive of the outcome variable and therefore do not indicate significance in the multiple regression (Tabachnick & Fidell, 2007). Pearson's correlation between the two independent variables was high, .781, but

did not reach multicollinearity – defined by a correlation of .90 or above (Tabachnick & Fidell, 2007). Again, the higher correlation could be an indicator that both of the independent predictors are sharing variance in the outcome remedial course midterm examination score.

The second multiple linear regression was performed using the outcome variable student's remedial course final examination score and the two independent predictors cumulative high school GPA and high school mathematics GPA. Results of the regression are presented in Table 4 and include the coefficient for each predictor (*B*), the associated standard errors (*SE B*), standardized regression coefficients (β), the t-statistic and significance values for the predictor variables.

Table 7

Multiple Regression Results for Final Examination Score Regressed on Independent Predictors of Cumulative High School GPA and High School Mathematics GPA (N = 67)

Variable	*B*	*SE B*	*β*	*t*	*Sig.*
Cumulative high school GPA	-5.23	10.46	-0.09	-.050	.619
High school mathematics GPA	18.23	8.33	0.41	2.19	.032

$F = 4.28$
$R^2 = .116$
Adjusted $R^2 = .089$

Note. Sig. = Significance (p-value).

This multiple regression model (using final examination score as the outcome variable) is significant $F\ (2, 65) = 4.28$, $p = .018$, with R^2 of .116 (*Adjusted* $R^2 = .089$) and 95% confidence limits ranging from 0 to .25. The adjusted R-square value of .089

indicates that approximately 9% of the variability in the dependent variable of remedial course final examination score was predicted the student's cumulative high school GPA and mathematics GPA.

The predictor of high school mathematics GPA was statistically significant, t (2) = 2.19, p = .032. The 95% confidence interval for the predictor of high school mathematics GPA was (1.602 to 34.857). Furthermore, the squared semi-partial correlation for the predictor of high school mathematics GPA was .065, indicating that this variable contributed 6.5% of unique variance to the model.

The size and direction of the relationship between high school mathematics GPA and the outcome of remedial course final score suggests that the remedial course final score increases when the high school mathematics GPA increases.

Research Question 3: Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?

Hypothesis 3a: There is a statistically significant association, or a significant indirect association, between the variables of (a) student's remedial course midterm examination score, and (b) the number of high school math courses completed.

Due to the ordinal nature of the number of high school math courses completed variable, a Spearman's rank order correlation was performed in lieu of the Pearson's correlation. Results were not statistically significant (ρ = .069, p = .573). Therefore, there is not sufficient evidence to indicate an association between the variables student's

remedial course midterm examination score, and the number of high school math courses completed.

Hypothesis 3b: There is a statistically significant association, or a significant indirect association, between the variables of (a) student's remedial course final examination score, and (b) the number of high school math courses completed.

Again, due to the ordinal nature of the number of high school math courses completed variable, a Spearman's rank order correlation was performed in lieu of the Pearson's correlation. Results were not statistically significant ($\rho = .001$, $p = .991$). Therefore, there is not sufficient evidence to indicate an association between the variables of (a) student's remedial course final examination score, and (b) the number of high school math courses completed.

Chapter Summary

Chapter IV began with a description of the participants and of the study. Inferential analyses of the variable constructs were briefly defined. Information pertaining to required assumptions for the inferential analyses was presented and discussed. Following the assumption section, hypothesis testing was performed.

Research question 1 asked, "Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?" A series of independent samples *t-test*s were performed with the independent student grouping variables of low cumulative high school GPA and high cumulative high school GPA. Significant differences in the mean remedial midterm examination scores were found and the research hypothesis was supported. The researcher attributes the lack

of difference in the mean remedial final examination scores to the smaller sample size of this study.

Research Question 2 asked, "Do students who have a higher high school mathematics grade average perform better on periodic course examinations in their remedial math courses?" A series of independent samples *t-test*s were performed with the independent student grouping variable low high school mathematics GPA higher high school mathematics GPA. Significant differences in the mean remedial midterm and final examination scores were found and the research hypothesis was supported.

Research Question 3 asked, "Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?" Two Spearman's rank order correlations were performed and statistical significance was not found between the number of high school mathematics courses taken and outcomes of midterm or final remedial math course examination scores. Research hypothesis 3 was not supported.

Chapter V

Summary, Conclusion, Recommendations, and Discussion

Introduction

Chapter V begins with a summary of the research study, including the research questions and a review of the process and findings of the study. The next section of the chapter includes the conclusions drawn from the research study the implications for policy and procedural changes at City College and other community colleges. Following is a section providing recommendations for action and future research. Closing the chapter is a discussion section that elaborates on potential policy decisions derived from the research.

Summary

This research study was conducted to analyze student placement in remedial math. Specifically, the purpose of this study was to examine whether a student's cumulative high school GPA or their high school mathematics grade average were a significant determinant of their performance in the remedial math sequence – as referenced by successful completion of the common midterm and final examinations. The analysis was accomplished by evaluating the transcripts of students enrolled in City College's two remedial mathematics courses, Math 098 and Math 099. Collected were the students' high school GPA, the number of mathematics courses that each student completed, and their high school mathematics grade average. This information was compared to the students' remedial mathematics midterm and final examination test scores. There were three questions that this research addressed:

1. Do students who have a higher cumulative high school GPA perform better on periodic course examinations in their remedial math courses?
2. Do students who have a higher high school mathematics grade average perform better on periodic course examinations in their remedial math courses?
3. Do students who take a higher number of high school mathematics courses perform better on periodic course examinations in their remedial math courses?

The research was guided by similar research that has been undertaken regarding the use of placement tests as either an adequate tool for placing students into remedial programs and courses or as a valid predictor of student success in remedial courses. Much of the prior research indicates statistical significance in the positive correlations between college mathematics preparation, placement test performance, and remedial course outcomes. Armstrong (2000) found a statistically significant relationship between placement test scores and the dependent variable of course grade; however, the coefficients were too low to be of much practical significance (less than a .35 correlation). Armstrong also developed a model that explained variance in course outcomes using test scores, student background data, and instructor differences in grading practices. To that end, he found that student dispositional characteristics (such as GPA, last mathematics grade, and number of years of mathematics studied in high school) explain a high proportion of variance in the dependent variable (20% of the variance in final grade was attributable to dispositional characteristics). Armstrong concluded that

student dispositional information is of more predictive value than standardized placement test (which accounted for less than 5% of the variance in final grade).

Jones, Davenport, Bryson, Bekhuis, & Zwick (1986) found a strong positive relationship between senior-year mathematics achievement test score and the number of high school mathematics courses taken – whereby, the higher the number of high school mathematics courses taken the greater the test score. Furthermore, and unexpectedly, they found that the relationship between mathematics achievement test score and number of high school mathematics courses taken was slightly stronger for the courses that the students reported taking than for the courses as recorded on the student's high school transcript.

Hoyt and Sorensen (2001) found a strong positive correlation between student mathematics preparation in high school and ACT test scores. However, they also found that while a strong positive correlation exists, students who took a "college preparatory" mathematics curriculum were still unprepared for college level math. In fact, over half of the students who successfully completed intermediate algebra and geometry had test scores placing them into remedial math courses. This finding was consistent with similar results obtained from the ACT Research Division in 1998 where "they found the average ACT math score of students completing algebra 1, algebra 2, and geometry nationwide was 18" (Hoyt & Sorensen, 2001, p. 28). The math cut score required at Utah Valley State College (the institution studied by Hoyt and Sorensen) was 23. Hoyt and Sorensen recognized that there were other factors than the level of math taken in high school that may have impacted remedial placement. Therefore, they evaluated the relationship between level of preparation in high school, grades in math courses, ethnicity, delayed

entry into college, and attendance at different high schools. They found in the first district studied that 79% of the students who did not need remedial math were correctly classified and 83% of the students who needed remedial math were correctly classified. For the second district, 84% of the students who did not need remedial math were correctly classified, and 77% of the students who needed remedial math were correctly classified. They also found that the student's level of math preparation in high school and grades were significant predictors of placement in remedial math. "The variables with the largest partial correlations were grades and level of math taken in high school" (Hoyt & Sorensen, 2001, p. 30). Furthermore, students earning higher grades were less likely to be placed into remedial math classes.

During this period of greater accountability in the outcomes provided by community colleges and general economic uncertainty characterized by the highest unemployment levels since the great depression, access to high quality education remains an important concern. As articulated by President Obama as he launched his $12 billion community college initiative (in July, 2009), community colleges have been identified as keys to moving our country from economic uncertainty to economic prosperity through the provision of workforce preparation, training, and baccalaureate transfer programs (Kellog & Tomsho, 2009). More recently, Vice President Joe Biden in his March, 2011 speech presented the "College Completion Tool Kit". The tool kit provides strategies to improve the accountability of post-secondary institutions such as performance-based funding, accelerate student learning and reduce the cost of education, and using data to drive decision making (United States Department of Education, 2011). While endeavoring in the improvement of post-secondary institution accountability and quality,

there could be unintended consequences related to students' access to those institutions. "Many in higher education equate academic standards with the selectivity of the institution or program; that is, the caliber of the entering students is considered the indicator of the academic standards of the institution" (Armstrong, 2000, p. 694). Armstrong continues by suggesting that "academic standards might be best thought of as what the institution or instructor imposes on the students at the exit point, not the skills students bring with them on entry" (p. 694). Institutional placement policies create barriers to college for many students when these policies prevent students from enrolling in courses in which they could be successful.

The percentage of students who leave high school unprepared for college-level work varies by the researcher and year. Bailey (2008) cites an Achieving the Dream database that shows that 61% of the students enrolled in any one of the eighty-three Achieving the Dream institutions are referred to their institution's lowest level developmental math course. Green and Forster (2003) state that 68% of all students who leave high school are unprepared for college-level work. They further state that these percentages are higher for Black and Hispanic students (80% and 84% unprepared respectively) who are already severely underrepresented in the pool of minimally qualified college applicants. The case for remedial education is made. Yet, how students are designated as being able to benefit from undertaking remedial studies represents a relative "gap" in the literature.

The concerns for remedial education are not new – as remedial education has a long history. The purpose of early remedial programs was to augment the competency level of students in different subjects. The roots of today's remedial programs can be

found in the earliest American colleges as they provided tutors for students who were underprepared in their skills with Greek and Latin. During the middle of the 18th century, land-grant colleges instituted preparatory programs for students who were weak in reading, writing, and arithmetic (Payne & Lyman, 1998; Merisotis & Phipps, 2000). Today, remedial courses are usually designed as basic courses that can adequately prepare students within a term or semester (Walker & Plata, 2000).

The use of placement tests to identify students needing remediation has been a customary and accepted practice among community colleges and universities. Placement tests are considered as "provid[ing] useful information not only about what students should know but what level of comprehension is required" (Golfin, Jordan, Hull, & Ruffin, 2005, p. 19). However, there appears to be general consensus in the literature in support of using multiple factors for college placement to include high school preparation, years of high school mathematics or English courses with placement test scores as a more successful placement policy (Ruiz, 2007; Hoyt & Sorensen, 2001; Armstrong, 2000; Jones, Davenport, Bryson, Bekhuis, & Zwick, 1986; Weber, 1985).

There are also cost considerations regarding remedial education. While necessary for many students, remedial education is also very costly as courses extend a student's college matriculation and are often more costly than regular college credit courses. In addition to being costly for the student, remedial programs are also costly for the colleges and government agencies that support them. It is estimated that remediation absorbs approximately $1 billion annually against a public higher education budget of approximately $115 billion (Breneman & Haarlow, 1998). However, there are others (such as Laurence Stienberg) who believe that $1 billion is a gross underestimation of the

total costs for remediation because it fails to account for changes in the college curriculum that places courses that at one time may have been considered remedial courses as "bone fide" academic courses (Breneman & Haarlow, 1998). These cost factors lead legislators and decision makers to be concerned with the quality of education provided by secondary institutions.

Despite cost factors, policies on remedial education vary across the country. While most all community and technical colleges across the nation offer remedial programs, there are many considerations about what institutions are best suited to provide remedial education to include holding K-12 institutions more accountable for the students that they graduate. However, more states are recommending that remedial programs be relegated to community colleges who they perceive as best able to address the remediation problem. There is also a movement afoot to pass the responsibility of teaching remedial courses to private institutions and learning centers (Phillippe & Sullivan, 2005). In the state of Illinois, the General Assembly decreed that community colleges be designated as the main provider of remedial education for under-prepared students entering college.

Although concerns for remedial programs have existed for many years and despite the growing trend of underprepared students, very little has been done to assess the effectiveness of remediation. It has been considered that this lack of assessment is related to the challenge of creating concrete measures or student learning outcomes for remedial courses. Additionally, many institutions do not track the progress of students after they complete remedial coursework nor do they have policies for testing entry and exit skills of remedial students (Weissman, Bulakowski, & Jumisko, 1997). Bettinger

and Long (2005) conducted a study that concluded that college students who have completed a remedial program perform on par with similar student who were not enrolled in remedial courses. They further found that students who were placed in math remediation were found to be 15% more likely to transfer to a four-year college than students with similar test scores and high school preparation who attended colleges with policies that did not require placement into remedial courses.

While much of the literature review focused on remedial education policies and program features, there is a body of research that expresses concern for the effect of placement into remedial courses on a student's self-efficacy. These studies find that remedial placement can impact student retention and they identify college placement policies as a means by which an institution aids in lowering a student's expectations – thereby affecting the student's sense of self-efficacy. In addition to college placement policies, research also identifies a teacher's low expectations regarding the performance ability of many remedial students as yet another way that the institution silently communicates or reinforces a student's sense of low self-efficacy.

This research study included a total of 74 records of students who were enrolled in Math 098 or Math 099 during the fall 2010 semester at City College and had high school transcripts on file with the institution. To respond to the first research question an independent samples *t-test* was used. The independent variable high school GPA was grouped into two categories of (a) those students with a high GPA (2.5 or above), and (b) those students with a low GPA (2.49 or below). In addition to the two independent samples *t-test*s, two multiple regressions were performed for each dependent variable outcome of (a) student's remedial course midterm examination score, and (b) student's

remedial course final examination score. Similarly, to respond to the second research question an independent samples *t-test* was used. The independent variable high school mathematics GPA was grouped into two categories of (a) those students with a high GPA (2.5 or above), and (b) those students with a low GPA (2.49 or below). In addition to the two independent samples *t-test*s, two multiple regressions were performed for each dependent variable outcome of (a) student's remedial course midterm examination score, and (b) student's remedial course final examination score. The third research question was divided into two hypotheses. Each hypothesis was addressed using a Spearman's rank order correlation.

Conclusions

While the research hypotheses 1 and 2 – related to identifying the predictive validity of cumulative high school GPA and mathematics GPA as compared to the student's performance on periodic course examinations – were generally supported, findings are viewed by the researcher as both positive and not so positive. Likely due to the small sample size used in the study, difference in the means for the test variable high school GPA and the outcome variable remedial course final examination score was not valid. However, differences in the means were valid for low cumulative high school GPA on the outcome variable midterm examination score, low cumulative mathematics GPA on the outcome variable midterm examination score, and higher cumulative mathematics GPA on the outcome variable final examination score. Although the *t-test*s supported the hypotheses made in this study, the multiple regression analysis did not make such a strong case as results were disappointingly similar to the Amstrong (2000) study. In comparing predictor variables high school GPA and mathematics GPA to the

outcome variable remedial course midterm examination score, the regression model suggests that a correlation exists when considering both high school GPA and mathematics GPA together – when combined these predictor variables explain approximately 10% of a student's midterm examination score. However, each predictor variable alone was not significant. While it is positive to explain 10% of the midterm examination score, approximately 90% is left unexplained by the model. Therefore, whether is this correlation is practically significant is left unanswered. In comparing predictor variables high school GPA and mathematics GPA to the outcome variable remedial course final examination score, the regression model suggests that a correlation exists when considering both high school GPA and mathematics GPA together – when combined the predictor variables explain approximately 9% of a student's midterm examination score. However, unlike the prior multiple regression model, significance was established for high school mathematics GPA on the outcome variable final examination score. This significance suggests that for every one unit of increase in a student's high school mathematics GPA the student's remedial mathematics final examination grade will increase by approximately 18 points.

Recommendations for Action and Further Study

The results of this study may not be surprising – as they validate the literature review findings which suggest that student characteristics such as high school GPA and high school mathematics grades can be an adequate placement tool for community college students (when considered with other placement tools).

As stated earlier, the recent concerns for remedial education are derived from a national movement for accountability from our nation's post-secondary institutions. This drive for accountability may create tension between access and standards.

> Access goals are achieved if all applicants with a secondary education credential are admitted to postsecondary programs. Along with commitment to access, community colleges also wish to maintain high standards, a goal that is threatened by the presence of large numbers of low-skilled entrants. (Perin, 2006, p. 340)

Previous research is rather conclusive regarding the ineffectiveness of the placement tests in predicting student success in remedial courses (Hughes & Scott-Clayton, 2011; Armstrong, 2000). Therefore, the results of this study will help City College and other community colleges recognize the contribution of a student's high school performance as a potential predictor of performance in the remedial mathematics sequence of courses. Implementing placement practices that consider cumulative high school GPA and mathematics grade averages in addition to placement tests can be of value in providing a success orientation for their students. The ultimate goal of this research is to help City College to make better placement decisions for the sake of minimizing (if not eliminating) the resources used to provide remediation for those students who can be successful in regular college-level courses. In making better placement decisions, there is also a significant impact to a student's sense of self-efficacy and may have a positive impact on student retention and completion.

As noted in the limitations section (of chapter III), student records selected for this study included those that contained not only the midterm and final examination scores for Math 098 and Math 099 courses taken in the fall 2010 semester, but also the student's high school GPA and mathematics grade average. Therefore, a copy of the students' high school transcript must have been on file in the college's Registrar's Office. While this practice may be adequate for the retrospective data collection nature of this study, this practice may not be practical in making real-time placement decisions. This limitation was also noted in the study performed by Jones, Davenport, Bryson, Bekhuis, & Zwick (1986) as they found that the relationship between mathematics achievement test score and number of high school mathematics courses taken was slightly stronger for the courses that the students reported taking than for the courses as recorded on the student's high school transcript. It is from this limitation that an opportunity for a future study arose whereby a researcher could use the placement test and student self-reported high school mathematical performance to determine if a correlation exists with student course placements and remedial course performance.

Additionally, the limitations section refers to the possibility of multiple latent independent and dependent variables. Some of these variables have been tested as indicated in the research collected for this study. Armstrong (2000) developed a model that explained variance in course outcomes using test scores, student background data, and instructor differences in grading practices. Again, it is from identified limitations that an opportunity for a future study arose whereby a researcher could use other latent variables – specifically those that control for differences in teacher standards or school

grading standards – to examine their affect on placement test results and school performance.

In addition to quantitative research, there is also an opportunity to qualitatively examine student perceptions regarding the quality of their high school mathematics preparation as compared to its relationship with either mathematics placement – as determined by placement test scores – or remedial course performance.

Discussion

Due to the use of correlational statistics in this study, there are inferences that can be made about how this information may be of practical use to both the researcher and other college administrators regarding placement testing and remedial education in general. Additionally, there are findings from the analysis of this research study that may not be directly related to the study, but are nonetheless useful. This section is dedicated to the discussion of these issues.

As it was presented earlier in this research study, post-secondary institutions have entered a period of greater scrutiny as a result of national discussions regarding the quality of education in the United States. Government and other stakeholders are demanding that higher education intuitions be more accountable to very specific outcomes. To that end, City College has embarked on a district-wide "reinvention" that is characterized by the establishment of four goals:

1. Increase the number of students earning college credentials of economic value,

2. Increase the rate of transfer to bachelor's degree programs,

3. Improve outcomes for students requiring remediation, and

4. Increase the number and share of Adult Basic Education (ABE) and English as a Second Language (ESL) students who advance to and succeed in college-level courses.

As it was also previously stated, these goals can create a tension between secondary and post-secondary institutions and this is most true for community colleges (as open enrollment institutions). Again, this information is particularly relevant for City College as it should be noted that ACT finds that 23% of the students tested by the ACT examination are ill-prepared for college algebra. However, at City College during the 2009-2010 academic year none (0%) of the students tested by the COMPASS placement exam were deemed ready for college algebra. City College enrollment is 98% Black. Therefore, the lack of college readiness seems to indicate a serious failure in the city's secondary institutions and may further illuminate a college readiness "gap" that may exist between White and Black students.

This notion is also supported when giving consideration to the average remedial mathematics course midterm and final examination scores of the students included in this study (66.83 and 55.66 respectively). While this study presents a concern for remedial placement, the researcher can not overlook the greater concern regarding student performance in remedial mathematics. Students may be properly placed through the implementation of better placement policies and procedures; however, the placement policies do not ensure student success in remedial courses. Therefore, the researcher

finds that greater scrutiny regarding the teaching learning standards and outcomes within remedial mathematics courses is necessary. The researcher has also considered that the problem with placement and remedial performance is not solved by addressing concerns only in the context of higher education. Rather, the data suggests that addressing these problems with secondary institutions is necessary to obtain better results.

It is also of great concern to the research that while there is significance in the differences between high school performance and remedial course midterm and final examination grades – whereby students with better high school performance tend to perform better on the examinations – practically, this may not yield a great change in the ratio of student placement into remedial mathematics to placement into college-level mathematics. It should be noted that the average high school GPA is 2.19 (median = 2.10) and the average mathematics GPA is 2.05 (median = 1.95). This is further evidence that the problems of student placement cannot be solved by the post-secondary institutions alone. It is also evidence that the entrance examination may not be a limiting factor in the placement of student into remedial course work for the majority of the students whose records were included in this study. The researcher believes that it is important to also consider an alignment of high school mathematics outcomes with the standards that are examined by COMPASS. Furthermore, it is important to ensure that the COMPASS examination tests the skills that are needed to ensure success in college-level mathematics courses.

Finally, it seems to be a necessity for administrators at City College to provide its faculty with better (and possibly more consistent) approaches to engage adult learners and ensure better learning outcomes for its remedial courses. It has been identified

through this research that a gap exists in the literature regarding the performance of remedial education programs. If remedial education outcomes are not measured, then it is impossible to improve teaching and student learning.

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