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## Success After Failure: An Examination of Credit Recovery Options and their Effect on College- and Career-Readiness

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SUCCESS AFTER FAILURE: AN EXAMINATION OF CREDIT RECOVERY  
OPTIONS AND THEIR EFFECT ON COLLEGE- AND CAREER-READINESS

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DISSERTATION

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A dissertation submitted in partial fulfillment of the  
requirements for the degree of Doctor of Philosophy in the  
College of Education  
at the University of Kentucky

By  
Kathryn Blair Johnson

Lexington, KY

Director: Dr. Margaret Mohr-Schroeder, Associate Professor of Mathematics Education

Lexington, KY

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## ABSTRACT OF DISSERTATION

### SUCCESS AFTER FAILURE: AN EXAMINATION OF CREDIT RECOVERY OPTIONS AND THEIR EFFECT ON COLLEGE- AND CAREER-READINESS

More than ever before, educators and researchers are keeping a keen eye on student college- and career-readiness. The widely adopted Common Core State Standards were written with the explicit goal of helping students to be college- or career-ready by the time they graduate from high school. However, many students experience setbacks, such as course failure, within their educational career placing them at risk for not reaching this goal. Because the ACT can predict student success in college, states often use benchmark scores from the exam to measure student college- and career-readiness. A student who fails to learn fundamental concepts in either Algebra I or Geometry will not score as well on the ACT and is not likely to meet benchmark scores for college- and career-readiness. It is important, then, for schools to provide credit recovery opportunities to students who do not pass these classes so they can master the content and earn a passing grade.

This research study examines different credit recovery options offered at one high school to students who failed Algebra I and/or Geometry. These options included re-taking the class, summer school, an online course, and a more unique mastery based program. Because students were nested within teachers, hierarchical linear modeling was used to determine associations between credit recovery options and the ACT mathematics score which is used to determine college- and career-readiness. Also considered were the effects of gender, race, socioeconomic status, and previous achievement indicated by PLAN mathematics scores. For Algebra I, no variables were found to be statistically significant as fixed effects, and only re-taking the class, PLAN mathematics scores, and identification as White were found to be statistically significant as random effects. For Geometry, identification as being African American was the only variable found to be statistically significant as a fixed effect, and re-taking the course and participation in summer school were both found to be statistically significant as random effects.

**KEYWORDS:** College- and Career-Readiness, Common Core State Standards, Course Failure, Algebra and Geometry, ACT

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Kathryn Blair Johnson

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June 15, 2015

SUCCESS AFTER FAILURE: AN EXAMINATION OF CREDIT RECOVERY  
OPTIONS AND THEIR EFFECT ON COLLEGE- AND CAREER-READINESS

By

Kathryn Blair Johnson

Dr. Margaret J. Mohr-Schroeder  
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June 15, 2015

This is dedicated to Kenny.  
You have always been there to help me to reach such great heights.  
Everything looks perfect. We'll stay.

## ACKNOWLEDGMENTS

Where to begin, in thanking the people who helped me reach this goal, is hard to decide. I first want to thank all of the professors I had in my coursework, each of whom were dedicated to helping every one of their students, and who provided me with the foundational knowledge to move forward in my research. Additionally, I am so very grateful to each member of my committee. Thank you to Dr. Cindy Jong, Dr. Michael Toland, and Dr. Xin Ma for your guidance and lending your expertise, helping me accomplish this task that might have seemed overwhelming. Thank you, thank you to my chair Dr. Margaret Mohr-Schroeder. Without your encouragement I would not have been brave enough to even start the program while still teaching full time. Thank you for giving so generously of your time and energy, keeping me calm and on track.

I also want to thank the members of my family. Thank you to my mother, Alison Messina, for being the kindest person I know. Your generosity never fails to amaze me. Thank you to my father, Frank Messina, for always believing (since I was a little girl, I'm pretty sure) I would get this degree, for setting an example of true life-long learning, and for a very special mug. Thank you to Kristin Messina, for being the best sister and friend I could imagine, and for teaching me through example to be a more compassionate person. Thank you, to my step-mother Denise Messina, for always being so supportive of my endeavors, not just in school but in life as well.

Thank you, also, to George and Katherine McCormick for their advice and encouragement, and always making me feel like this was going to work out. Thank you also to my lovely friends and colleagues at school who cheered me on throughout the program.

I'm not sure how to begin to thank you, Kenny, for encouraging me to chase this dream. Thank you for always supporting me, even though it meant many nights herding seven dogs on your own. Thank you also for celebrating each step along with the way with me, often with gestures extravagantly thoughtful. Most of all, thank you for marrying me.

Finally, I am aware especially today that not everyone has been given so many opportunities in their life, and that some people have to overcome tremendous barriers to attain an education. Thank you God, so much, for your continuous blessings, and for the life you've given me, filled with love, support, and open doors.

Thank you, thank you, thank you!!!



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## CHAPTER K INTRODUCTION

In 2010, Kentucky became the first state to adopt the Common Core State Standards (CCSS). According to Terry Holliday, Kentucky's Commissioner of Education at the time, the standards challenge students to think critically, creatively, and to problem solve rather than memorize. With the adoption of the CCSS, the state began to measure the successful graduation of high school seniors not just by the award of a diploma, but also the ability to demonstrate college- and career-readiness. The state uses benchmark scores on the ACT to determine whether a student is college- and career-ready. These are the scores that would ensure that a student is able to enroll in a credit-bearing course in college without first having to take a transitional or remedial course. This study examined college- and career-readiness for mathematics in particular; according to ACT's 2014 report *The Condition of College & Career Readiness*, only 43% of the nation's graduates met the mathematics benchmark allowing them to enroll in College Algebra their freshman year.

The challenge of preparing students that meet college- and career-readiness benchmarks has become a major focus for high schools in Kentucky, especially since in 2014, only 31% of the state's graduating seniors met the mathematics benchmark indicating readiness for credit-bearing College Algebra. Teachers and administrators strive to create opportunities for students to learn required content and to score highly on the ACT, and research confirms a close relationship between coursework and ACT scores (ACT, 2014b). However, not all students are successful in all of their classes. The ACT mathematics portion covers 6 content areas: pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry. A student

who fails to learn fundamental concepts in either Algebra I or Geometry will not score as well on the ACT and is likely to not meet benchmark scores for college- and career-readiness. It is the hope that students in Algebra I and Geometry classes learn the material and pass the class on their first attempt. However, it is important for schools to provide credit recovery opportunities to students who do not pass these classes so that they can master the content and earn a passing grade.

### **Purpose Statement**

The purpose of this study was to examine the credit recovery options offered to students in one high school in Kennlee County Public Schools<sup>1</sup> who have failed Algebra I, Geometry, or both. Credit recovery options included re-taking the course in a traditional classroom setting, Plato (an online course taken by students individually), summer school, and an alternative mastery based course offered the mornings before school, commonly called “Zero Hour”. From information in transcripts, students who failed Algebra I and/or Geometry were identified along the type of credit recovery option used. Using hierarchical linear modeling, the relationship between credit recovery options and students’ college- and career-readiness as measured by their ACT mathematics score was explored. Based on the results of the analyses, recommendations were made concerning how credit recovery options were associated with student ability to meet college- and career-readiness standards while also considering the role of student characteristics. The study was conducted through the lens of postpositivism, as analysis was conducted using objective measures in order to make conclusions concerning the alignment of test scores and participation in credit recovery options.

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<sup>1</sup> Pseudonyms used throughout

## **Research Questions**

The following questions were addressed by the study:

1. Which credit recovery option (Plato, summer school, re-taking a course, or Zero Hour) is most closely associated with student ability to meet the college- and career-readiness benchmark score of 19 on the mathematics portion of the ACT taken in the spring of their junior year?
2. To what extent do student characteristics such as race, gender, and socioeconomic status explain variability in ACT scores for students who have failed Algebra I and/or Geometry?

## **Significance of the Study**

Only 43% of the nation's seniors in 2014 demonstrated readiness for College Algebra. For students in Kentucky, the number is significantly lower at 31% (ACT, 2014b). In Chapter 2, the Conceptual Framework for this study helps outline more specifically the importance of college- and career-readiness and how states, such as Kentucky, measure student preparedness for taking on the challenges after high school through benchmark scores on the ACT. While the reasons students might fail to achieve these scores are numerous and complex, one important factor is student mastery of foundational material in courses such as Algebra I and Geometry. Because Kentucky's scores are well below the national average, it is of particular importance that schools in the state provide students who fail courses remediation options that allow for true mastery of the material. This study delves in to how different credit recovery programs affect student achievement and what other student characteristics play a role in the attainment of college- and career-readiness benchmark scores.

## **Definition of Terms**

*ACT test:* A four-part, norm-referenced, standards-based multiple-choice test used to determine educational achievement in English, Mathematics, Science, and Reading used often by colleges to help determine student admissions and also by many states, including Kentucky, as part of their state-wide assessment (ACT, 2014c). The test was originally named the American College Test, though is now shortened simply to the ACT.

*ACT mathematics test:* A 60 multiple-choice question assessment given as part of the ACT designed to assess mathematical reasoning skills typically acquired by 12<sup>th</sup>-graders in the U.S. The six content areas covered are pre-algebra, elementary algebra, intermediate algebra, coordinate geometry, plane geometry, and trigonometry (ACT, 2014c).

*College- and career-readiness:* The level of preparation needed for students to succeed in credit-bearing courses in postsecondary education with a high probability of success, meaning approximately a 50% chance of earning a B or better and a 75% chance of earning a C or better (Conley, 2007).

*College- and career-readiness benchmark scores:* The minimum ACT test scores found to be associated with students' high probability of success in credit-bearing college courses. For mathematics, readiness for a basic college mathematics course is indicated by a 19, readiness for College Algebra by a 22, and readiness for Calculus is indicated by a score of 27. Attainment of benchmark scores is associated with students' 50% chance of making a B or better and 75% chance of earning a C or better in the corresponding freshman college course (ACT, Inc., 2014a).

*PLAN test:* The PLAN test is produced by the same testing company as the ACT, and has been administered to Kentucky students in the fall of their tenth-grade year, often to be used as a predictor of the success a student will have on the ACT. The test, however, began being phased out in the 2014-2015 school year.

### **Assumptions**

1. All teachers administering any type of remediation option made a good faith effort to ensure only students who had mastered the material would successfully complete the credit recovery program and be given credit for the failed course.
2. All student scores on the ACT mathematics portion, taken in the spring of their junior year, represent the best of the student's effort and ability.

### **Delimitations**

This study used pre-existing data obtained from Kennlee County. The credit recovery options administered to the student participants were not randomly assigned. Data reflects the real-world decisions made by teachers, counselors, parents, and students concerning which credit recovery option each individual student might participate in. Because of this lack of random assignment to the different credit recovery options, the results of this study are not generalizable to the population of all high school mathematics students.

Additionally, data from only one high school was used for the study. One reason was the inconsistency in record keeping at the other schools in the district, making it difficult, if not impossible, to determine from student records the method of credit recovery participated in. Additionally, the school chosen also utilized more numerous credit recovery options than the other schools, allowing for a more in-depth examination



of what type of remediation program might be aligned with student success in terms of college- and career-readiness.

### **Organization of the Study**

This study is organized into five chapters. Chapter 1 provides an introduction, including the research questions along with the purpose and significance of the study. Chapter 2 contains the Conceptual Framework of the study, along with a review of relevant literature. Chapter 3 outlines the methodology and procedures used in conducting the research. Chapter 4 provides the findings from the data analysis. Chapter 5 provides discussion concerning the results along with suggestions for future research.

## **CHAPTER ~~IX~~ LITERATURE REVIEW**

Much has been written about the importance of college- and career-readiness and student attainment of this goal. This chapter first outlines the Conceptual Framework of the study, examining more closely the concept of college- and career-readiness. The literature review highlights relevant findings, with a section paying particular attention to the role of mathematics in college- and career-readiness. The next section reviews details about the CCSS, followed by information concerning the ACT and how benchmark scores are used to measure college- and career-readiness. The next section includes findings from the literature concerning students as they transition from middle to high school, and why the first few years in secondary school are so critical to student success. Following this is a description of eight common characteristics of struggling learners. Additionally, gender, race, and socioeconomic status are considered to be covariates in the study, and there are three sections outlining the major findings concerning each of these characteristics and their effects on mathematical achievement, as well as information concerning how these three factors interact. Next are findings concerning interventions that can help address issues and allow for high mathematical achievement by all students, regardless of race, gender, or socioeconomic status, along with a portion that addresses gaps in the literature and how this study will add to the research base. Finally, there are descriptions detailing the common credit recovery options examined in this study.

### **Conceptual Framework**

The purpose of this study was to better understand how to help students move from failure to success. More specifically, it aimed to answer the question of how

schools can best provide students who have failed the critical classes of Algebra I or Geometry opportunities to be successful both in high school and beyond.

Educators today, especially those in secondary schools, keep a keen eye on student college- and career-readiness. There are varying definitions of the concept and this study will use the definitions and ideas laid out by David Conley in his works written through the Educational Policy Improvement Center amongst his other articles and studies. Conley (2007) described an operational definition of college- and career-readiness as the level of preparation needed for students to succeed in credit-bearing courses in postsecondary education, with success in these classes considered to be completion of the course with a level of understanding that would allow students to take the next course in the sequence or subject area, along with having an approximately 50% chance of earning a B or better and a 75% chance of earning a C or better.

Conley (2012) noted the skills and knowledge needed to succeed in college overlap significantly with those needed for students who will enter workforce training programs directly out of high school. He went on to claim there is “little useful purpose” (p. 4) of separating these students into two groups, and suggested educators embrace college-readiness and career-readiness as a single goal.

Research has confirmed the importance of a college-educated population. Hout (2005) noted that earning a college degree creates a better life in terms of financial stability, health, and ability to contribute to a well-functioning society. Carnevale and Rose (2011) called postsecondary education a “sure return on investment” and claimed it has “become an arbiter of economic success and upward mobility” (p. 10). A 2011 report prepared by Symonds, Schwartz, and Ferguson showed how the United States’ job

market has changed over the past 40 or so years. The authors found that between 1973 and 2007, the country added a total of 63 million jobs, but positions requiring no more than a high school diploma actually fell by two million. They also stated that in 1971, workers with a high school education or less made up 72% of the workforce, but that number had dropped to 41% by 2011. Such statistics demonstrate how important it is for students to move on from high school to postsecondary education.

As a whole, students do see the value of college and they hold high expectations concerning postsecondary education and career aspirations consistently across gender, social class, racial groups, and academic achievement levels (Wimberley and Noeth, 2005). Even so, educational progress is not at the needed level for a globally competitive world. The United States ranked 15<sup>th</sup> amongst 20 major industrialized countries in the number of bachelor degrees held by citizens ages 25-34, and is additionally the only country in the Organisation for Economic Co-operation and Development whose college completion rate was lower for younger citizens than it was for the older population (Rothman, 2012).

Studies also show that while it is extremely important for students to go on to attain a postsecondary education, many students are graduating from high school underprepared to take on the challenges of college. In 2014, only 26% of tested students met the College Readiness Benchmarks in all four subjects of English, reading, mathematics, and science (ACT, 2014a). In addition to costing students and their families more time and money, it has also been found that students who enroll in remedial courses are more likely to drop out of college compared to students who are not in need of remediation (Rothman, 2012). In fact, students who drop out of college often

do so in their first year, most frequently citing academic difficulty (Allen & Sconing, 2005).

Given such statistics, there is much concern within the U.S. about the academic preparedness of students. This focus is not new. Barnes, Slate, and Rojas-LeBouef (2010) traced the beginnings of a national push towards college- and career-readiness to the National Commission on Excellence in Education's 1983 report *A Nation at Risk: An Imperative for Educational Reform*. Barnes et al. claimed that while much of the report was overly dire in its assessment of the country's educational status, two important outcomes of the report include a shift in schools being judged by student achievement levels (rather than resources received by the school) and also a much needed call for reducing the achievement gap between races and groups of differing socioeconomic status. Along with the emphasis on gauging school success by student outcome came the call for using standardized test scores as the primary measurement of educational progress. This trend continued with the Improving America's Schools Act of 1994 under President Clinton, and was furthered by the No Child Left Behind Act of 2001 (NCLB) signed into law by President Bush. NCLB was put forth after researchers became dismayed at student academic under-preparedness for college, levels of high school dropout, wide achievement gaps, and the large percentages of students enrolled in remedial coursework during their college career.

Looking back at NCLB, researchers began to fear the law was far too punitive. President Obama responded by waiving achievement deadlines and granting states more freedom to set student performance goals and develop plans to help struggling schools. In exchange for accepting these waivers, states had to agree to adopt rigorous standards

aimed at student attainment of college- and career-readiness (House, 2013). Many of the states, in fact, had already adopted the CCSS which were designed with the explicit goal of college- and career-ready students (Rothman, 2012). Along with other measures such as Annual Yearly Progress goals set forth in NCLB, secondary schools in the U.S. are now using college- and career-readiness as a main indicator of the success of their students.

Following this, states needed some type of measure to demonstrate this readiness. Kentucky began in 2008 administering the ACT to all public school high school students in the spring of their junior year and using benchmark scores from the test to determine college- and career-readiness. There are three benchmark scores for mathematics in Kentucky, with a score of 19 indicating readiness for an introductory college mathematics course (such as statistics or applied mathematics), 22 demonstrating readiness for College Algebra, and 27 indicating preparedness for Calculus. The ACT is taken by about 1.6 million high school students each year and the company's website provides a large amount of documentation concerning the exam. According to the company's report *The Condition of College and Career Readiness* (2013a), "ACT is first and foremost an achievement test. It is a measure whose tasks correspond to recognized high school learning experiences, measuring what students are able to do with what they have learned at school" (p. 30). The CCSS were written with a goal of student college- and career-readiness, and as indicated in the above quote, ACT measures high school academic achievement, which has been closely linked to success in college (Geiser & Santelices, 2007). In fact, longitudinal data provided by ACT was used in the development of the CCSS, identifying knowledge and skills shown to be necessary for

the successful transition to postsecondary education and workforce training.

Additionally, ACT periodically surveys teachers and postsecondary educators, making sure the content included on the test accurately reflects what is taught in schools. This is done through the ACT National Curriculum Survey, given every three to five years.

While traditionally the survey targeted middle school, secondary, and postsecondary educators, in 2012 the company also began seeking input from elementary school teachers. According to ACT (2012), the National Curriculum Survey demonstrates the company's commitment to using evidence and research to validate standards, assessment, and benchmarks.

It is important, of course, that the benchmark scores used to determine college- and career-readiness do in fact provide an accurate prediction of student success. Conley (2007) noted the benchmarks are “the minimum ACT test scores required for students to have a high probability of success in corresponding credit-bearing first year college courses” (p. 9). Having a “high probability of success” means that a student has approximately a 50% chance of earning a B or better and approximately a 75% chance of earning a C or better in the corresponding college course. These benchmark scores were figured using data from 214 institutions and over 230,000 students, weighted so that it would be representative of two- and four-year postsecondary institutions throughout the country. Using this data, ACT determined the benchmark scores that indicate students are ready to be successful in their college courses. Because of ACT's alignment with curriculum standards and their wide use of empirical data to ensure scores do in fact predict college success, these test scores provide states a quantifiable measure of college- and career-readiness.

Therefore, this study utilized a framework in which college- and career-readiness is an important goal and that ACT scores can be used as an appropriate proxy to measure the attainment of that goal. However, the process of producing students who can demonstrate this level of preparedness is complex. In recognition of that, this study also included as part of its framework other concepts important to the educational process that could help students who do not pass foundational mathematics courses move from failure to success.

These concepts include student factors such as gender, race, and socioeconomic status that can affect student achievement. The literature review for this study examined the roles of each of these, how they interact, and how they can, unfortunately, put some students at a disadvantage. In a 2012 position paper addressing achievement gaps, the National Council of Teachers of Mathematics (NCTM) stated, “All students should have the opportunity to receive high-quality mathematics instruction, learn challenging grade-level content, and receive the support necessary to be successful” (para. 4). In accordance with this statement, this study was conducted with a genuine belief that despite challenges, all students can perform at high levels, even if they have suffered academic setbacks such as course failure along the way.

Conley (2012) defined college- and career-readiness as a level of preparedness needed by students in order to succeed after high school graduation. Additionally, in acknowledgement that moving from high school to college successfully is extremely complicated, Conley developed four “Key” sets of skills students need in order to make the successful transition to postsecondary education. These include Key Content Knowledge, Key Cognitive Strategies, Key Learning Skills and Techniques, and Key



Transition Knowledge and Skills. While all four Keys are important to student readiness, the most applicable to this study is Key Content Knowledge. Key Content Knowledge includes foundational content and the “big ideas” (p. 2) and also an understanding of the structure of knowledge. Key Content Knowledge includes technical knowledge, ways students interact with knowledge, ways students perceive content knowledge to be useful, and also their willingness to put forth the effort to learn the material. In that same report, Conley mentioned how these Keys are demonstrated in student academic performance, and one of these is a “quantitative literacy” (p. 3) based on the understanding of measurement and number systems, applied through the concepts of algebra and geometry. The participants of this study were students who had failed at least one those two important courses, usually early in their high school career, putting them at risk for being unprepared in the Key Content Knowledge needed to be successful in later mathematics courses both in high school and college. Confirming the negative impact of failing courses in ninth-grade, research has shown more than 60% of students who eventually drop out of high school failed a quarter of their ninth-grade classes (Legters & Kerr, 2001).

Because of their failure of Algebra I or Geometry, these students can be thought of as struggling learners. Along with students who have some type of learning disability, Allsopp, Kyger, and Lovin (2007) identified struggling learners as those that are “traditionally identified in the literature as *students at risk for school failure*” (p. 4). The authors identified eight common characteristics of struggling learners. These include learned helplessness, passive learning, memory difficulties, attention difficulties, cognitive/metacognitive thinking deficits, processing deficits, low level of academic

achievement, and mathematics anxiety. These characteristics were explored further in the literature review section of this study, and research was conducted through a lens that takes into account these special characteristics.

The purpose of this study was to examine credit recovery options provided to students. Other than re-taking a course, each of these methods provided opportunities to students to learn material and earn credit more quickly than in a traditional classroom. Because students have already fulfilled the seat time required for a course, credit recovery options allow students to focus on demonstration of mastery of the material in order to earn their credit (Watson & Gemin, 2008). It is likely, then, the most successful credit recovery option, meaning the one that is most closely associated with student college- and career-readiness, is the one that in a short amount of time best addresses the special characteristics laid out by Allsopp et al. (2007) and helps students fill in gaps in their Key Content Knowledge as proposed by Conley (2012).

In summary, this study examined the role of credit recovery options provided to students who failed Algebra I and/or Geometry as ways to help these students achieve success. For this study, success was defined as a demonstration of college- and career-readiness through the attainment of benchmark scores on the ACT. Research has demonstrated the importance of college- and career-readiness both to individual students and to society as a whole. Though true student readiness for success in college can be complex, ACT scores have been shown to predict student ability to enroll in credit-bearing courses their freshman year with enough success to move to subsequent courses (Kaye, Lord, & Bottoms, 2006). Student factors such as gender, race, and socioeconomic status have been shown to affect academic achievement (Hyde & Mertz, 2009; Lubienski,

2002; Sirin, 2005), and their role was accounted for in both the statistical analysis of the data and in the interpretation of the results. Also examined were additional concepts that apply to the learning context for these participants. Because of their failure of Algebra I and/or Geometry, it was likely many of these students exhibited at least some of Allsopp et al.'s common characteristics of struggling learners. These students were also at risk for not meeting some of Conley's four Keys to college- and career-readiness, especially in their Key Content Knowledge. Though statistics concerning current levels of student achievement can seem grim, the framework of this study was based on the belief that these students who once experienced failure can indeed experience success, and this study adds to the body of research knowledge concerning ways this could be accomplished.

### **The Importance of College- and Career-Readiness**

Never before has there been such an intense demand in the U.S. for workers with a postsecondary education. Instead of an economy based on industry, jobs now call for employees with skills in service, information, and technology (Wimberly & Noeth, 2005). There has been a rise in the U.S. college graduation rate, but the increase is still not enough to fill the demand. "Although the U.S. college graduation rate increased from 42% in 2000 to 49% in 2009, the rate increased much faster in other countries" (Rothman, 2012, p. 10). Employers worry that students leave school unprepared to succeed in the work place. Areas of greatest concern include basic skills related to work ethic and timeliness, mathematics and science abilities, and reading comprehension. The costs to workplaces forced to remediate these skills are tremendous. For example, the cost in Michigan alone is most conservatively estimated to be \$222 million per year

(McCormick & Lucas, 2011). There is also a large need for remediation amongst college students, with 40% of students entering college needing to take at least one remedial course, and numbers even higher for ethnic minorities (Rothman, 2012). In answer to this growing problem, the U.S. government has moved towards policies that will help high school seniors graduate college- and career-ready.

In order to be considered college-ready, a student must be able to enroll at a two-year or four-year institution in credit-bearing college classes without first having to enroll in any remedial courses. For recent graduates entering the work place, they are considered career-ready if they are able to enroll in employment training programs that will prepare them for careers that offer competitive, livable salaries that provide opportunities for advancement (Rothman, 2012). Studies have shown there are increased commonalities between the skills needed to be college-ready and those needed to be career-ready, and employers are looking for applicants that have the same knowledge expected of a student entering college (Achieve, 2005). Because of this, government officials and educators have embraced these as a single, common goal, namely, college- and career-ready.

There have been many benefits of this new focus on college- and career-readiness. In their 2009 survey of the structure and demographics of high schools, Balfanz, McPartland, and Shaw found that the new call for accountability has created high schools that are more focused and academic. There is also a renewed push for increasing high school graduation rates (Trotter, 2008). Approximately two-thirds of high school graduates are enrolling in college right after their senior year, a sign that more students understand the skills needed to be competitive (McCormick & Lucas,

2011). “Students recognize the connection between postsecondary credentials and employment opportunities, express a commitment to postsecondary education, and perceive it as a key to gaining the knowledge and necessary skills to obtain employment” (Wimberly & Noeth, 2005, p. 1) and by eighth-grade, more than 80% of students believe they will earn a college degree, while almost half also believe they will go on to also earn a graduate or professional degree.

In addition to students, there are other groups keenly interested in the college- and career-readiness of graduating high school seniors. Attainment of this goal is largely determined by scores on tests such as the ACT, and high school teachers are often held accountable for the results and invest a large amount of their time and energy in helping students reach the benchmarks. Parents, of course, are also highly interested, as most of them consider college to be a key to their child’s future success. Employers, after claiming high school graduates come to them unprepared, are certainly interested in reforms that might produce a better workforce. Another group of stakeholders are state and national government officials who know well the value of education (McCormick & Lucas, 2011).

As students understand the importance of higher education, it is encouraging to see enrollments in postsecondary institutions have indeed been increasing. Undergraduate enrollment has gone from 12.0 million in 1990, to 17.7 million in 2012, and is projected to be 20.3 million by 2023 (Kena, et al., 2014). However, enrollment in college does not mean a student is necessarily ready to take on the challenge. About 40% of students across the country must enroll in remedial coursework once they enter postsecondary education, and in a 2005 study, 39% of the college graduates surveyed

indicated they had been underprepared for college or the workplace (Rothman, 2012). In U.S. community colleges alone, the annual cost to students enrolled in remedial courses is estimated at \$4 billion (Scott-Clayton & Rodriguez, 2012). With tremendous financial cost and the link between remediation and dropping out of college, it is clear that as a nation, students need to be better prepared for academic challenges after high school.

### **The Role of Mathematics in College- and Career-Readiness**

Jobs increasingly demand applicants have obtained a postsecondary education. This also holds true for mathematics specifically, as it is predicted that two-thirds of future jobs will require the use of college-level mathematics (Huebner, Corbett, & Phillippo, 2008). In an appearance before the House Committee on Education, the Vice President of Achieve, the nonprofit educational reform organization, called mathematics the “gateway” to college readiness. There is also a strong correlation between whether a student is prepared for college mathematics and his or her likelihood to complete a college degree. Mathematics provides students with the ability to interpret, analyze, and evaluate data, all skills that are increasingly important in a world with global societies and a tremendous amount of quantitative information to sift through.

As with college- and career-readiness in general, students are unfortunately not adequately prepared in mathematics when they graduate from high school. Students can be denied access to four-year institutions and universities based on their lack of mathematical readiness alone (Huebner et al., 2008). This readiness can also affect the choices students have concerning college majors and careers. American 15-year olds ranked 25<sup>th</sup> among 30 developed countries in terms of mathematical literacy, raising

concerns about whether the U. S. can continue to be competitive unless students show a higher level of mathematics competency (McCormick & Lucas, 2011).

The large number of students graduating from high school unprepared for the demands of college mathematics is concerning. One possible reason for this under-preparedness is the high number of students not enrolled in college-preparatory classes. Completion of Algebra II has been linked with student ability to enroll directly in credit-bearing courses as college freshman and their ability to earn a C or better in their first college mathematics course (Jonas et al., 2012). In fact, enrollment in rigorous coursework is a better predictor of student success than either income or education level of parents (Huebner et al., 2008). There has also been a serious misalignment between the beliefs of secondary teachers and those of postsecondary instructors concerning what content should be taught. Interestingly, secondary teachers often overestimate the number of specific topics that need to be taught in high school compared to postsecondary educators, who would instead encourage a more in-depth coverage of fundamental concepts (Conley, Drummond, de Gonzalez, Rooseboom, & Stout, 2011b).

### **The Common Core State Standards**

In 2010, the CCSS for mathematics and English Language Arts were released, representing an “unprecedented” shift away from standards that varied state-to-state (Porter, McMaken, Hwang, & Yang, 2011, p. 103). Government and educational leaders in the country were interested more than ever before in student preparedness for postsecondary education, and the standards were designed explicitly around the goal of college- and career-readiness for all students. Instead of standards that varied in different

areas of the country, expectations were to become uniform, a step towards equity in educational opportunity for all students (Rothman, 2012).

The development of the CCSS was led by the National Governor’s Association Center for Best Practices and the Council of Chief State School Officers (CCSSO). Input was sought from teachers, parents, school administrators, state leaders, and educational experts from around the country. Additionally, a tremendous amount of data and other evidence was used in the shaping of the standards. This included the work of high-performing states, frameworks developed for the National Assessment of Educational Progress, the Benchmarks of the American Diploma Project, curriculum surveys, academic research, and assessment data concerning college- and career-readiness (King, 2011). The CCSS were written with the goals of making clear what teachers and assessments should focus on and raising expectations for student achievement in the U.S. to be at levels comparable with the top education systems in the world (Conley et al., 2011b). Consistent with the literature, it was found that because the skills needed to be ready for postsecondary education are similar to those needed in the job market, the CCSS do not distinguish between college-readiness and career-readiness (King, 2011).

Development of the CCSS began in April 2009 and teams were first created to develop anchor standards. These would be the standards in English Language Arts and mathematics that would prepare students to be college- and career-ready by the time they graduated their senior year. Rothman (2012) claimed this is one of the hallmark differences between the CCSS and various standards developed by individual states—that in order for a standard to be included, it would need to clearly play a role in college- and career-readiness. He went on to note topics that were “interesting but that were not



essential” (p. 3) were not included allowing for a streamlining of the process of deciding what was to be included and what was not.

Consistent with previous findings, ACT (2007) noted a difference between what high school teachers and postsecondary educators saw as a priority, with high school teachers often rating a much larger number of topics as being “important” or “very important” than their postsecondary counterparts. By bringing in experts from around the country representing varied educational levels, the CCSS helped address these differences. After the anchor standards were created, a separate team designed a series of grade-by-grade standards meant to lead students to the mastery of the content needed for college- and career-readiness by the time they graduated from high school.

Additionally, the CCSS do not just include a list of topics that would help students be college- and career-ready, but also provide a format and sequence that help teachers fully implement the standards and allow students to reach the college- and career-readiness goal. Conley (2011a) noted that the brain organizes related pieces of information into schema and claimed that non-routine use of this information allows for the creation of more complex connections along with a deeper understanding and integration into cognitive structures. “The Common Core State Standards are designed to develop these larger cognitive structures by identifying key knowledge and skills, organizing these elements sequentially and progressively, and then infusing more cognitive complexity into the knowledge-acquisition process” (Conley, 2011a, p. 2). The developers of the CCSS made a particular effort to sequence mathematical topics so they would be presented in a logical and coherent manner, and the organization of the key

knowledge and skills outlined in the standards can be an important step towards student mastery of content.

Naturally, researchers have begun to examine whether the CCSS do indeed fulfill their goal of addressing students' college- and career-readiness. The 2011 Educational Policy Improvement Study examined the CCSS to determine if they, in fact, reflect the knowledge and skills needed for postsecondary success. Instructors from two- and four-year postsecondary institutions from around the country were asked to rate each standard by its applicability and its importance in success in college. "The study suggests students that are generally proficient in the Common Core standards will likely be ready for a wide range of postsecondary courses, and the more Common Core standards in which they are proficient, the wider the range of postsecondary courses they will be ready to undertake" (p. 7). In mathematics, amongst the highest rated standards were "Reasoning Quantitatively" and "Interpreting Functions." Algebra topics that also scored highly included creating equations to describe numbers or relationships, interpreting the structure of expressions, and solving problems with different equations. In the survey, geometry standards scored lower, suggesting there may be a need to review or consolidate those standards to increase their applicability.

### **The ACT and Benchmark Scores as a Measure of College- and Career-Readiness**

Overall, the development and implementation of the CCSS have reflected the emphasis on preparing students to become college- and career-ready. With the implementation of new standards, states needed a way to measure student growth and achievement. In Kentucky, the measurement decided upon was the ACT, which the state had already begun to administer in 2008 to all public high school juniors as part of the

state's accountability system. The ACT is a norm-referenced exam and was created to test students over what they have learned, rather than aptitudes. The exam measures academic achievement, which is closely related to college- and career-readiness. ACT developed benchmark scores to indicate student readiness to take on the challenge of postsecondary coursework. Because different students will be enrolled in different mathematics courses as freshman, Kentucky uses three benchmark scores. The ACT benchmark score demonstrating students are ready for an introductory credit-bearing mathematics college course is 19. There are two other benchmark scores, with 22 demonstrating readiness for College Algebra and 27 demonstrating readiness for Calculus. For the purpose of this study, a student was considered college- and career-ready if they met the minimum ACT benchmark score of 19.

ACT provides a large amount of data on national and state trends in college- and career-readiness. According to the report *The Condition of College and Career Readiness* (2014a), 43% of all U.S. high school graduates tested met the mathematics benchmark of 22, indicating preparedness for College Algebra without first needing to take a remedial mathematics course. Also, an additional 8% of students were within two scale points of meeting benchmarks. The percentage of students meeting the mathematics benchmark score of 22 had generally been increasing, growing approximately one percentage point per year between 2009 (42%) to 2012 (46%), but with a decrease in the 2013 results to 44% and another decrease to 43% in 2014. In 2014, 64% of U.S. ACT-tested high school graduates met the English benchmark, 44% met the Reading benchmark, 37% met the Science benchmark, and 26% met the benchmarks for all four subjects (ACT, 2014a).

While high school students have until they graduate to demonstrate college- and career-readiness, schools in Kentucky keep a keen eye on data from the state-mandated junior year administration of the ACT. The state measures college- and career-readiness in mathematics through the attainment of a 19, indicating readiness for a basic college mathematics course, as opposed to the benchmark of 22 which is often used in national reports such as those published by ACT. Statewide, 43.5% of public high school juniors met the mathematics benchmark of 19. An even lower percentage of the state's juniors meet the benchmark score of 22, demonstrating readiness for College Algebra. However, students in Kennlee County scored better than state averages, with 54% meeting the college and career-readiness benchmark of 19.

### **Development of the ACT Assessment**

In addition to publishing student score results, ACT also provides literature documenting the process for writing ACT test items. The company looks closely at test specifications, which they call “blueprints” for constructing the test (ACT, 2013b). These specifications include descriptions of the content and cognitive level of skills that need to be assessed on the test, a description of the statistical characteristics of test items, and a description of the way content for the test was chosen. This involves a multiple step process, beginning with an examination of the content included in state standards. This became more straightforward with the majority of states adopting the CCSS, and learning objectives in grades seven through twelve are taken into consideration in this review. Next, the company examines textbooks on state-approved lists, again looking at content covered in grades seven through twelve. Finally, educators at secondary and postsecondary levels are consulted to gain feedback on the content taught in those same

grades considered to be prerequisite for postsecondary success. These three sources provide the basis for deciding the scope of content covered by the exam. The basic structure and majority of content remains the same from year to year in order to allow for score comparisons. However, there is an on-going process of fine-tuning. Panels of consultants review new test forms to ensure content accuracy and verify the content on the test does indeed match with the content taught in secondary schools considered to be necessary for students moving to postsecondary education.

ACT also strives to use items that truly measure student achievement. The goal is to provide questions that allow for differentiation between students who are well prepared and those who are not. Item writers contract with ACT and are provided with a guide to help them develop test materials. This guide includes information about item content and scope, types, skill levels, and expected difficulties. Item writers are usually only asked to write 15-30 questions with the goal that a wide variety of topics will be produced by using numerous writers and to also increase test security since no writer would be aware of a large portion of upcoming tests.

Also listed amongst the requirement for test items is fairness. The idea the ACT is fair to all students taking the test is one the company takes quite seriously. The ACT is created to assess knowledge and skills in specific content areas, and allowing factors other than academic knowledge and skills, such as context or language, to affect scores would provide an inaccurate picture of student achievement and potential (ACT, 2013b). Thus, when reviewing submitted test items, an effort is made to select items equally familiar to all groups of students regardless of background characteristics such as ethnicity, family structure, socioeconomic status, and rural, urban, or suburban lifestyle

(ACT, 2013b). Through these requirements, ACT hopes to provide a test that indicates a student's true college- and career-readiness without scores being affected by some other type of external factor putting some students at a disadvantage.

Items that meet requirements for content, difficulty, and fairness are then edited to meet standard ACT stylistic conventions before they are further screened. External reviewers include content experts and consultants examining fairness. Comments from these reviewers are taken into consideration by ACT staff and items are revised accordingly. Through these multiple steps, the company strives to have a bank of questions that have been reviewed (and re-reviewed) for content, reflection of curriculum and grade level appropriateness, and fairness. These items are then pre-tested on a national administration of the ACT. Results of this pre-test allow for statistical analysis concerning the appropriate level of difficulty and the discrimination of student skill level. Items must meet all criteria in order to be included on future forms of the ACT. Pools of acceptable items are created and individual forms of the ACT are drawn from this bank of questions, with care taken to ensure that each ACT exam includes a distribution of items reflecting variety and balance in terms of both content and multicultural and gender representation.

### **The Importance of the Early High School Years**

The purpose of this study was to look closely at students who fail either Algebra I or Geometry, the credit recovery options they participated in, and how this affected their likelihood of being college- and career-ready. In reviewing the literature, it is clear that freshman and sophomore years in high school, the time that most students take Algebra I and Geometry, are particularly important in terms of whether or not students will be

college- and career-ready. Students who are retained in ninth-grade are much more likely to eventually drop out of school (Balfanz et al., 2002). Failing to meet requirements to move to the next grade, along with failing two or more classes, both increase the chance that a student will not successfully finish high school (Watson & Gemin, 2008). “Over 60% of students who eventually dropped out of high school failed at least 25% of their credits in the ninth-grade, while only 8% of their peers who eventually graduated had similar difficulty” (Watson & Gemin, 2008, p. 4).

Unfortunately, many students arrive in high school unprepared for academic success. There is a dearth of systematic research in the type of skills and knowledge students coming to high school behind grade level lack (Balfanz et al., 2002). However, research does indicate the process of transferring to a new school can cause students to have declining academic performance, increased absences, and more frequent behavioral disruptions. Compounding this issue is the difference between middle and high school, both academically and socially. Ninth grade is often the first year in which students must earn passing grades in order to be promoted from one grade to the next (McCallumore & Sparapani, 2011). In light of these facts, it is no surprise research shows ninth-graders have the lowest grade point average and the majority of failing grades amongst all high school students.

In 2001, a review of existing research on mathematical learning by the National Research Council, along with interviews with high school teachers, identified some of the common skills students who were struggling as ninth-graders seemed to be missing. Operations with rational numbers and with integers (positives and negatives), were identified as areas in which many students need remediation (Balfanz et al., 2002).

Additionally, it was found that even when struggling students are identified as needing extra help, this help does not actually target the most critical skills the students are missing. Traditionally, remediation focuses in on low level skills, such as those involving whole number operations. However, it is the more intermediate level skills, like those taught in middle school, which would be more helpful to these students. The transition from arithmetic to mathematics, along with mathematical reasoning, are also areas in which students behind grade level may struggle (Balfanz et al., 2002).

Additionally, much of the content in middle grades was found to be repetitive, partially explaining the deficit in skills as due to a lack of exposure to more advanced mathematical concepts. However, the article was written well before the adoption of the CCSS. It can be hoped that through this careful re-structuring and re-alignment of standards, middle school students will indeed be taught content with the appropriate amount of depth and rigor.

Even with improved implementation of appropriate standards, it is likely the problem of student failures in courses such as Algebra I and Geometry will continue. The next section of this literature review contains additional information about the participants in this study, and characteristics that might contribute to their difficulties in the mathematics classroom.

### **Characteristics of Struggling Learners**

Students who are at risk of school failure are often considered in the literature to be struggling learners (Allsopp et al., 2007). Because all participants in this study failed at least one semester of high school mathematics, it is important to consider any



characteristics of these struggling learners that might influence the effectiveness of credit recovery options.

The first characteristic of struggling learners is learned helplessness. Students who fail courses such as Algebra I or Geometry have often experienced mathematical difficulty before ever entering that class. Because of this, these students are more likely to believe they cannot succeed in mathematics or will fail no matter how much effort they put forth. Following this, the more often these students experience poor results in the classroom, the more ingrained this type of thinking becomes. Along these same lines, a second characteristic is passive learning. These students have often internalized beliefs they are unlikely to be successful. Therefore, it is not surprising they would be unlikely to set forth on their own to find solutions to challenging problems or actively look for ways to connect new concepts to ones they have previously learned.

The next two characteristics are memory and attention difficulties. Memory difficulties include when a student has trouble remembering basic arithmetic facts, steps to solving complex problems, mathematical vocabulary, and also difficulties in retrieving information previously learned. Attention difficulties, on the other hand, affect student ability to attend to the most important information presented to them in class. These difficulties are not a result of attending to too little, but attending to too much stimuli without the ability to properly identify what information would be most helpful to them and what information is not relevant (Allsopp et al., 2007).

Two other characteristics of struggling learners are metacognitive/cognitive thinking deficits and processing deficits. First, a metacognitive thinking deficit influences student ability to communicate mathematics effectively and monitor their own

understanding of the mathematical content. Processing deficits affect how students might misperceive information they gain in class. These deficits can be specific to the method through which the information is given, with some students experiencing visual, motor, or speech deficits. Some struggling learners process information properly, but do so more slowly than their peers, increasing the chance that they fall behind in class and miss important instruction.

The last two of the eight common characteristics of struggling learners often result, in part at least, from the first six – low levels of academic achievement and mathematical anxiety. It is, of course, the low level of achievement in mathematics that helped identify student participants for this study, and it is likely their course failure was at least partially caused by one or more of the previous six characteristics. Additionally, academic difficulty often occurs across subject areas and quickly accumulates with gaps in knowledge and understanding, making it even more difficult to learn new material. The final characteristic is mathematical anxiety. Again, it is not surprising students who have experienced some serious barriers in learning and have suffered academic setbacks could very well feel anxious about their mathematical skills. Additionally, the anxiety experienced can go on to intensify the effects of other difficulties and deficits, making it all the more difficult to succeed in the classroom (Allsopp et al., 2007).

Of course, each student is unique and will vary in how well they fit the above characteristics of a struggling learner. Additionally, there are other factors that influence how well students learn and perform in class, and the next three sections of this literature review examine how the three commonly studied student characteristics of gender, race, and socioeconomic status play a role in academic success or failure.

## **Gender and its Effect on Mathematical Achievement**

The idea that gender can affect mathematical achievement is quite old. In fact, researchers began looking into differences in abilities and behavior in the 1880's (Hyde & Mertz, 2009). Over the years, there has been quite a bit of variation in the information provided by gender-related studies. This portion of the literature review will first highlight findings that demonstrate some differences in the genders relating to learning mathematics and mathematical achievement along with possible reasons for these discrepancies. Next, information will be provided concerning whether or not gender differences are quite as pronounced as researchers had originally perceived, and the implications of these findings.

Gender differences in mathematical achievement are not unique to the U.S. In an examination of data from the Third International Mathematics and Science Study (TIMSS), achievement differences between genders during students' final year of secondary school were noted in 44 of the 45 countries studied (Ercikan, McCreith, & Lapointe, 2005). Data from the National Assessment of Educational Progress (NAEP) indicates that while gender gaps are not large, they are quite persistent despite increases in overall performances for both groups (McGraw, Lubienski, & Strutchens, 2006). Gender differences, when they exist, almost always favor males, with the exception of computational tasks. Additionally, these gender gaps tend to increase with age and are particularly prominent amongst high-performing students (McGraw et al., 2006).

Gender differences have been found to be specific to certain mathematical skills. Some areas with differences include problem solving strategies and performance tasks involving computations, rational numbers, measurement, and spatial visualization

(McGraw et al., 2006). Measurement was found to be the concept with the most consistent gender performance gap in a 2000 review of NAEP data, perhaps being a consequence of differences in the leisure activities participated in by girls and boys (Ansel and Doerr, 2000). Other studies have noted gender difference in visual-spatial tasks and have provided possible explanations such as evolutionary differences caused by the role of traditionally male tasks, such as hunting, that require more of this type of orientation than the typical female tasks (Niederle & Vesterlund, 2010).

Analysis of NAEP data also reveals gender differences in particular mathematical content areas vary by grade level. In 4<sup>th</sup>-grade, males performed better in number and operations, data analysis, algebra and functions, and measurement (McGraw et al., 2006). By 8<sup>th</sup>-grade, the gap persisted for number and operations, data analysis, and measurement, and in 12<sup>th</sup>-grade, the differences in performance were found in geometry, number and operations, and measurement. Overall, while a lack of NAEP Grade 12 data makes comparisons difficult, trends seemed to indicate the gaps in number and operations remain in place across grade levels, and as students get older gaps decrease for algebra and functions while increasing for geometry, measurement, and data analysis.

Other research shows while gender gaps do favor males in many content areas, girls in fact perform better in others. Numerous studies have shown boys fare better on tasks involving measurement, proportionality, geometry, spatial geometry, analytic geometry, trigonometry and applications of mathematics. Additionally, other studies have shown that girls do better in computation, set operation, and symbolic relation, while performances in algebra were about the same for both male and female students (Ma, 1995). Differences in performance scores can also vary depending on the content,

format, and cognitive level of the test, along with the age at which the test is administered (Tate, 1997).

Opinions on why gender differences occur have varied widely throughout the years. Theories have ranged from the “sadly deficient” (p. 8801) brain size of females held by researchers in the nineteenth century (Hyde & Mertz, 2009), to less extreme views in the late twentieth century concerning gender differences in cerebral organization (Voyer 1998), to others claiming socialization is the main cause of gender differences (Felson & Trudeau, 1991). The literature provides quite a bit of information concerning this last idea—that cultural and social factors can account for much of mathematical achievement differences. The next portion of this literature review examines these wide-ranging factors and how they affect mathematical learning.

“Current research provides abundant evidence for the impact of sociocultural and other environmental factors on the development and nurturing of mathematical skills and talent and the size, if any, of math gender gaps” (Hyde & Mertz, 2009, p. 8805). Data from the Second International Mathematics Study (SIMS) shows the size of the gender gap for mathematical performance for countries correlated -0.55 with the percent of women in the workforce (Baker and Jones, 1993). More recently, 2003 data from the Program for International Student Assessment (PISA) showed that nations with greater gender equality usually have a smaller gender gap for mathematical performance (Guiso, Monte, Sapienza & Zingales, 2008). Social factors affecting the gender gap include influences such as differing amounts of attention given to students by teachers, guidance counselors pushing female students in one direction and male students in another, and a lack of positive role models in mathematics-related fields (Hyde & Mertz, 2009). School

factors such as teaching methods also influence mathematical achievement, and some researchers claim females, in particular, benefit from instruction based in problem solving and cooperative group work as it allows students to construct mathematical ideas (McGraw et al., 2006).

The literature provides other possible reasons for achievement differences between boys and girls. One is the attitudes and opinions held by male and female students. In addition to looking at other NAEP performance data, McGraw et al. (2006) also examined the outcomes of responses to questions measuring student affect such as “I like mathematics,” “I am good at mathematics,” and “I understand most of what goes on in mathematics class.” Differences between male and female responses were more pronounced at the 4<sup>th</sup>-grade level than they were at the 8<sup>th</sup>- or 12<sup>th</sup>-grade level. At the 4<sup>th</sup>-grade level, girls were seven percentage points less likely than boys to report the statement “I like mathematics” is “a lot like me,” while also being 13 percentage points less likely to say the same about the statement “I am good at mathematics.” The authors do caution, however, that these results might be a product of female students being more inclined to answer these questions less affirmatively than male classmates, regardless of whether or not they really do like and are good at mathematics. Concerning high school students, the authors note male 12<sup>th</sup>-grade students are statistically significantly more likely than their female counterparts to agree with statements such as “I like mathematics” and “I am good at mathematics,” though, interesting, the two groups did not differ with statistical significance in agreeing with the statement “I understand most of what goes on in mathematics class.” The authors found male students were more likely than female students to have a positive self-concept with respect to mathematics,

and went on to note factors that have been associated with differences in attitudes in mathematics including teacher beliefs and expectations, parent expectations, and peer influences. In a separate study examining student attitude, positive attitude was associated with higher mathematics achievement, but the variable was shown to be a stronger predictor for females than it was for males (Ercikan et al., 2005).

Elsewhere, researchers have examined additional topics as they relate to the gender gap in mathematical achievement. Devine, Fawcett, Szucs, and Dowker (2012) examined mathematics anxiety in secondary students. They found overall, female students experienced more mathematics anxiety than males, though they also experienced more test anxiety in general. When controlling for test anxiety, boys experienced only a marginal negative relationship between mathematics anxiety and mathematical performance. However, the relationship between mathematics anxiety and performance remained strong for female students, even when controlling for test anxiety, indicating the girls experienced an anxiety that is specific to mathematics “above and beyond” (p. 7) their anxiety over testing in general.

Other researchers have considered the influence of classroom teachers on gender differences in mathematics. In a 2000 qualitative study, Levi interviewed elementary school teachers concerning the issue of gender inequity and found there are three common roles teachers choose to take on as a way to combat the issue. The first role included teachers providing equal mathematical opportunities to all students, but “respecting differences” by not pressing the issue if a child did not seem to particularly enjoy mathematics. The second role involved a conscious effort to provide exactly the same experience to each and every student, sometimes including detailed methods such

as rotating through index cards with student names to make sure each child is called on equally for answers or making sure the two genders were equally represented amongst word problems presented in class. Levi claimed that she did not expect that anyone might argue against treating girls and boys equally in the classroom. However, noting research shows that for the most part girls and boys usually are treated equally, Levi identified a third role taken on by teachers who believe that girls should actually be pushed harder than boys towards mathematics to help make up for societal gender inequalities. Lately, though, the idea that teacher bias contributes to gender differences has become more highly criticized. While researchers have indeed claimed students do pick up on teacher bias and respond accordingly, “the available evidence on the extent to which male and female teachers share any particular bias in how they interact with girls or boys is more limited and contradictory” (Dee, 2007, p. 532).

Another possibility for the cause of achievement gaps identified in the literature was stereotype threat which is “being at risk of confirming, as self-characteristic, a negative stereotype about one’s group” (Steele and Aronson , 1995, p. 797). The concept of stereotype threat was found in the literature concerning both gender and racial gaps for mathematical performance. Researchers wonder if underperformance by both females and minorities can be, at least partially, blamed on expectations by society that this will indeed be the case. The concept of stereotype threat caught a lot of traction in the mid 1990’s, though more recently some authors are beginning to question its influence. In relation to stereotype threat’s effect on gender gaps, Stoet and Geary (2012) wrote, “We conclude that although stereotype threat may affect some women, the existing state of knowledge does not support the current level of enthusiasm for this as a mechanism



underlying the gender gap in mathematics” (p. 93). The authors go on to argue an overestimation of the effects of stereotype threat can unfortunately discourage research into other explanations and interventions that might be effective in closing the gender gap.

Evidence of gender differences often includes references to the amount of female participation in both upper level mathematics courses and careers involving mathematics. The state of girls’ enrollment in high level mathematics courses at the secondary level seems to be changing over the years. A popular explanation for the performance gap was once girls were less likely than boys to take upper level mathematics courses (Hyde & Mertz, 2009). However, by the beginning of the 21<sup>st</sup> century, the trend no longer held true, with girls taking Calculus in high school as often as boys. Additionally, girls might now be more willing to take challenging mathematics courses due to increased requirements for high school graduation and college admission (Hyde & Mertz, 2009). While course enrollment in secondary schools might be similar between the genders, beyond high school female students are still less likely to persist in the study of higher level mathematics and pursue careers in mathematics-related fields (McGraw et al., 2006).

Despite the many studies examining gender differences in mathematical performance, there is considerable evidence in the literature indicating these gaps are not as dramatic as they might once have seemed. A widely quoted statement was Mullin’s 1975 claim “In the mathematics assessment, the advantage displayed by males, particularly at older ages, can only be described as overwhelming” (Fennema, 1977, p. 7). Researchers now are more optimistic. By the early 1990’s, research was showing gender

differences between males and females were not as significant as differences within those gender groups (McGraw et al. 2006). Similarly, a meta-analysis examining gender differences in performance results from 100 studies involving more than three million individuals, indicated  $d = -0.05$ , an effect so small as to indicate no gender difference (Hyde, Fennema, and Lamon, 1990). Additionally, there was no evidence for gender differences in the understanding of mathematical concepts for students of any age, though high school males did exhibit an advantage over females in performance outcomes for complex problem solving that was not distinguishable in elementary and middle school (Hyde et al., 1990). When 2008 NAEP data was examined for performance on tasks categorized as “hard” and determined by researchers to involve complex problem solving, effect sizes of gender differences were found to an average of  $d = 0.07$ , an amount the researchers referred to as “trivial” (Hyde & Mertz, 2009, p. 8802). Along the same lines, a 2008 study using data from 10 states including more than seven million students showed when data was averaged across the states, gender differences in all grades were close to zero with  $d$  values ranging from -0.02 to 0.06 (Hyde, Lindberg, Linn, Ellis, & Williams, 2008).

Consistent with the findings that gender differences might not be as extreme as once thought, elementary school performance on word problems has been shown to be larger between different countries than it is between genders (Hyde & Linn, 2006). Additionally, gender is actually a poor predictor of whether a child will major in mathematics in college, with mathematics achievement scores in either middle or high school being a better predictor (Hyde & Linn, 2006). Ma found in his 1995 study of achievement differences between Canadian and Asian students that there has in fact been

a “narrowing trend in gender differences over time” (p. 118) with gender differences in both 8<sup>th</sup>-grade and 12<sup>th</sup>-grade too small ( $d = 0.50$ ) to provide much meaning.

As it becomes more widely accepted girls are not at a large disadvantage, it has also become more common for females to pursue careers in science, technology, mathematics, and engineering (STEM). U.S. doctoral degrees earned by women in mathematics and statistics went from 8% in 1970 to 32% in 2006 (Hyde & Mertz, 2009). Trends such as the increase in female participation in STEM-related fields are encouraging, and it can be hoped that the gender gap, whatever size it is, will continue to close. However, there are other student characteristics that affect achievement, and the next section of this literature review focuses on how race can be a factor in mathematical performance.

### **Race and its Effect on Mathematical Achievement**

Even in 1985, when gender differences were thought to be more pronounced, researchers were finding racial-ethnic differences in mathematics achievement were more prominent than those caused by gender (Tate, 1997). Awareness of racial gaps has remained strong, as evidenced by Yan and Lin’s 2005 comment, “Academic underachievement among African American youths is a social concern that has reached disturbing proportions” (p. 119). A 2002 examination of NAEP data compared the achievement gap between African American and White students in both 1990 and 2000, and while the performance differences between the two groups remained the roughly the same in 4<sup>th</sup>- and 12<sup>th</sup>-grades, the gap had actually increased in 8<sup>th</sup>-grade, as “...the 2000 data reveal the persistence of large achievement disparities, with White students significantly outscoring their Black and Hispanic counterparts” (Lubienski, 2002, p. 271).

The literature provides many possible explanations for the racial gap in mathematics performance scores and studies indicate students' families are of vast importance. Parent involvement helps distinguish between successful and unsuccessful African American students (Yan, 1990). In a 2007 article concerning student engagement in urban classrooms, Uekawa, Borman, and Lee examined different types of classroom social organizations, finding students were often put in classrooms where the culture did not match their family's norms. As an example, Native American and Mexican American families often encouraged at home learning patterns that were group oriented and involved collaboration over competition, which may not have been compatible with the type of learning encouraged in schools. On the other hand, traditional classrooms often housed White, middle-class teachers who engaged in teaching practices most familiar to White, middle-class students.

Yan and Lin (2005) looked closely into parent roles as they related to mathematical achievement, studying White, African American, Hispanic, and Asian 12<sup>th</sup>-graders. The authors viewed parental involvement as a type of social capital and broke it into three dimensions: family obligations, family norms, and parent information networks. Family obligations were seen as a family's responsibility to adopt certain norms in the educational lives of their children such as participation in parent-teacher organizations, attendance at school programs targeting future educational planning, and discussing school matters in what the authors called an "intensive investment" (p. 117) in their child's educational outcome. Family norms included things such as family rules, educational expectations, and parent-teenager relationships. Parent information networks

referred to parental contact with school and access to knowledge concerning their child's schoolwork, friends, and the parents of friends.

The study showed there were differences in the levels of parental involvement between the racial groups. African American parents contacted the school concerning their child's performance with the highest frequency. Hispanic American parents and African American parents reported having the strictest family rules. White families were found to engage in their child's schooling at a higher level than the other groups studied, and Asian American parents were found to have the highest expectations for educational achievement. Educational expectations was the strongest predictor of academic success amongst the tested dimensions for all four racial groups, with standardized coefficients of 0.08 for African Americans, 0.15 for Hispanic Americans and Asian students, and 0.24 for White students (Yan & Lin, 2005).

While family expectations and norms play an important role in student achievement, factors inside schools also make a difference. A 2000 study found, on average, teachers of African American students spend more time per week on mathematics instruction as compared to teachers of White students (Structchens & Silver, 2000). Another difference found was calculator usage. White students were more often allowed to use calculators on daily assignments and on tests while African American students were more likely to be given multiple-choice tests without the use of a calculator. This suggests African American students were more likely to be tested on computational skills while White students were tested on content involving more complex reasoning skills (Structchens & Silver, 2000).

Another issue that compounds racial performance gaps is enrollment in mathematics courses in high school. While enrollment in Algebra and Geometry are roughly the same for White and African American students, there are still differences in upper level courses, and in 1996, 25% of White seniors were enrolled in Pre-Calculus, while only 17% of their African American classmates took the same course (Lubienski, 2002). The trend held true in Calculus as well, with an enrollment of 13% and 7% of White and African American students respectively. Other school factors important in racial performance gaps might include tracking. Placing students on high or low tracks can certainly influence the courses they will take and thus their exposure to mathematical instruction. “Students in low-track classes (disproportionately high percentages of whom are low-income and minority students) are far less likely than other students to be taking courses that emphasize traditional academic science and mathematics content” (Oakes, 1990, pp. 9-10). In addition to the fact that low-track classes are less rigorous, they are often taught by the least qualified teachers. There is also a difference between advantaged schools and more disadvantaged ones as “...high-track students in the least advantaged schools are often taught by teachers who are less qualified than those teaching low-track students in more advantaged schools” (Oakes, 1990, p. 11).

Another factor that should be considered, as it was in the review of literature concerning gender, is student differences in opinions concerning mathematics and mathematics instruction. An examination of 1996 NAEP results showed that African American students reported liking mathematics, believing that mathematics is useful, and spending as much time (if not more) on homework than their White classmates (Lubienski, 2002). African American students were also more likely to agree with

statements such as “There is only one way to solve a math problem” and “Learning mathematics is mostly memorizing facts.” This seems in line with previously mentioned findings concerning assessment differences involving African American students being more likely to be tested on computational skills rather than higher order thinking (Strutchens & Silver, 2000).

One further issue to be considered is possible racial bias by teachers in response to widely spread information concerning the academic underperformance of minority students, though results of studies concerning teacher bias have been mixed. While there has been some evidence in the past that the mathematical performance of African American students is sometimes underestimated in comparison to their actual test scores, other studies have demonstrated there is little evidence of such teacher bias (Riegle-Crumb & Humphries, 2012).

Another theory that has been suggested to explain the racial gap in academic achievement is the Acting White hypothesis, which is the idea that African American students might purposefully underachieve in school to avoid “sanctioning” (Wildhagen, 2011, p. 404) by their same-race peers who associate academic success with White cultural norms. A study examining data from the Education Longitudinal Study (ELS) tested this idea that African American students sometimes do not make their best effort at achieving academically so that they will not be called out as “acting white” by their peers. There was not much evidence identified of overt peer stigmatization for African Americans who excelled in the classroom, though there were sometimes more subtle “mild social penalties” (Wildhagen, 2011, p. 424). However, items on the ELS may not be able to identify all ways in which these students might in fact be negatively influenced

by the Acting White hypothesis, meaning these effects might have been underestimated in the study.

When reviewing the literature concerning racial differences in performance scores, it is rare to find an article that does not make some mention of socioeconomic status as well. The next section of this literature review contains findings related specifically to socioeconomic status and its influence on mathematical achievement, followed by a review of findings showing that race and socioeconomic status are intertwined factors, often difficult to completely separate.

### **Socioeconomic Status and its Effect on Mathematical Achievement**

“Socioeconomic status (SES) is probably the most widely used contextual variable in education research” (Sirin, 2005, p. 417). Data from the Program for International Student Assessment (PISA) showed in 95% of the countries studied, students with higher family socioeconomic status scored higher in mathematical performance (Chiu & Xihua, 2008). Middle and upper socioeconomic status students enter school as young children already performing better in mathematics than their lower socioeconomic status peers (Secada, 1992). An examination of results from the TIMSS also found high levels of association between socioeconomic status and educational achievement for students in the U.S. (Ercikan et al., 2005).

As with both gender and race, there are many factors in why socioeconomic status-based achievement gaps occur. Multiple studies have shown that students of higher socioeconomic status are judged more favorably than students of lower socioeconomic status, even when they perform similarly in class. Because students of higher socioeconomic status tend to achieve more highly academically, teachers may



develop expectancies that student outcomes are pre-determined and they are therefore likely to feel ineffective when working with students of lower social status (Auwarter & Aruguete, 2008).

Other research shows the effect of socioeconomic status can be mitigated by teaching methods. Constructivist teaching approaches can help reduce achievement differences between student socioeconomic status groups (Wong & Lee, 1998). A student's habitus, or what has been called someone's cultural niche, can also affect student achievement. Because school curriculum and practices often reflect middle-class norms, students of lower socioeconomic status are at increased risk for having a habitus that does not overlap with what and how they are taught at school. This is similar to the family norms discussed previously concerning race, with both concepts pointing to possibility that academic achievement can be affected by a cultural misalignment between home and school (Uekawa et al., 2007).

A wealth of knowledge can be gained by looking at the results of Sirin's 2005 meta-analysis concerning socioeconomic status and academic achievement. Before providing results on performance differences based on socioeconomic status, the author makes an important point about the measurement of this factor. In the 1960's and 1970's, researchers would classify a student in a socioeconomic bracket based solely on the father's education and/or occupation. Current research instead takes many more factors into account, such as family income, mother's education, and family structure. When examining data, researchers are now also more likely to take into account moderating factors such as race, neighborhood characteristic, and student grade level. This more carefully considered combination and a cognizance of the influence on

outcomes by other moderating factors allows researchers to get a clearer picture on what portion of performance differences can truly be attributed to socioeconomic status.

In the same article, Sirin outlines some of the ways socioeconomic status plays a role in a child's achievement. Students are affected by their socioeconomic status before they arrive at school because of differences in resources and access to social capital. Also, because income levels are a major determinant of the neighborhood in which a child lives, socioeconomic status also affects the type of school and classroom environment a child has access to. Research shows schools in lower socioeconomic areas do, in fact, have less access to materials and fare unfavorably when compared to schools in higher socioeconomic areas in terms of teacher experience and teacher-to-student ratios. Other research confirms the relationship between differences in school socioeconomic status, resources available at school, and academic achievement of students (Unnever, Kerckhoff & Robinson, 2000). The location of a school should be taken into account, since the relationship between socioeconomic status and achievement is stronger in suburban schools than it is in urban ones (Sirin, 2005).

High levels of parental education are also associated with student participation in advanced mathematics courses. In fact, this factor has been shown to be as important in predicting student participation in these courses as student confidence in and attitude towards mathematics (Ercikan et al, 2005). Schlee, Mullis, and Shriner (2009) also found education levels for parents were good predictors of academic achievement, though they note that the causes of this relationship are not well understood. "Few studies are able to disentangle parents' schooling from other sources of advantage, such as cognitive endowments, that may have increased achievement among both parents and children"

(Duncan & Magnuson, 2005, p. 41). There are other possibilities for the link between low socioeconomic status and poor academic achievement, many of which include factors that affect children before they ever reach school. Larger amounts of financial resources provide better access to quality prenatal care, good nutrition, stimulating learning environments in the home, and safe neighborhoods in which children can thrive (Duncan & Magnuson, 2005). Other theories suggest the negative effects of low socioeconomic effects are indirect, with economic hardship causing emotional distress in parents, who are then less able to be attentive to children and their educational needs (Schlee et al., 2009).

Studies have also explored the role of socioeconomic status in parental involvement. Researchers are tasked with finding if higher parental involvement is truly associated with higher levels of student success, and also whether or not differing socioeconomic status is associated with differing levels of parental involvement. Before delving more deeply, the first issue to address is how parental involvement might be measured. Previous studies included activities such as attendance at school events, reading at home, and helping with homework (Grolnick, Benjet, Kurowski, & Apostoleris, 1997). Other studies include home supervision and the discussion of school activities along with help in planning academic programs (Sui-Chu & Willms, 1996). More generally, Grolnick et al. (1997) note their definition of parental involvement as “the dedication of resources by the parent to the child within a given domain” (p. 538). They describe three types of involvement including behavior, cognitive-intellectual, and personal. Participation in school events and helping with homework are behaviors that demonstrate involvement. Cognitive-intellectual aspects include exposing children to

educationally stimulating environments and conversations. Personal involvement includes keeping up with what is happening in the child's school life.

The effects of parental involvement on student achievement can vary depending on the type. For example, a study of eighth-graders demonstrated involvement in school through volunteering or Parent-Teacher organizations have little to no effect on mathematics achievement, while discussing school at home and helping children choose their academic program had the strongest effect (Sui-Chu & Willms, 1996). Research results concerning the role of family socioeconomic status in amounts of parental involvement have also been somewhat mixed. Sui-Chu and Willms (1996) found family socioeconomic status has been shown to have “virtually no relationship” (p. 329) to home supervision and was only moderately related to the discussion of school activities, contact with school personnel, and volunteering and attendance at school events. The authors note that in their study, about 10% of variation in parental involvement could be explained by measures of family background. They also found when taking parent involvement into account, the overall effect of socioeconomic status on academic achievement was reduced by about 7%.

When examining the role socioeconomic status in differing levels of parental involvement, one might consider the concept of cultural capital. Because public schools are mainly middle-class institutions that embrace middle-class values, patterns of communications, and organization, children raised in middle-class homes more readily benefit from school life (Sui-Chu & Willms, 1996). As was previously discussed in the section concerning the effects of race, a child's habitus can affect their ability to navigate school successfully. Research concerning socioeconomic status similarly shows that a

mismatch between home and school culture might discourage parents from being directly involved in their child's schooling, or cause them to be less successful in the attempts they do make.

Further evidence of this idea can be found by examining Calarco's 2014 study on how both student and parent behavior in school matters can be affected by social class as evidenced by the way students advocated for themselves in the classroom. Middle-class parents were more likely to encourage a "by-any-means" strategy, meaning the parents actively intervened in what happened in school and wanted their children to do the same. These parents taught their children to feel entitled to help at school, with one middle-class parent saying "teachers are there to help" (p. 15). On the other hand, results showed working-class parents were more likely to employ a "no-excuses" approach that encouraged children to manage educational challenges on their own rather than "pestering teachers" (p. 19), with these parents tending to equate seeking out help with laziness. Overall, students who adopted the "by-any-means" strategy encouraged by middle-class parents tended to have better academic results, with teachers more quickly recognizing the needs of these students over those who were downplaying their need for assistance.

Yet another topic related to mathematical achievement is student opportunity to take higher level mathematics courses. Research confirms enrollment in these higher level courses does in fact lead to higher academic achievement, including the attainment of a college degree. In 1999, the U.S. Department of Education published a study called *Answer in the Tool Box: Academic Intensity, Attendance Patterns, and Bachelor's Degree Attainment* that examined a cohort of students that graduated high school in 1982

and were followed through 1993 to examine their collegiate outcomes. In 2006, Adelman published a follow-up study, meant to replicate the original to see if trends found in the first still seemed applicable. He found schools throughout the country offered differing levels of “opportunity-to-learn” (p. 3). Additionally, there are approximately 15,000 school districts in the U.S., and unsurprisingly, course offerings can vary widely from district to district. An examination of data from the TIMSS also showed the U.S. had a particularly strong relationship between socioeconomic status and opportunity-to-learn, a claim linked to the U.S. also having a stronger correlation between socioeconomic status and general academic achievement than 32 out of the 40 countries studied (Schmidt, Cogan, & McKnight, 2011).

More specifically, students of the lowest socioeconomic status have been shown to be much less likely to attend schools that offered any mathematics course above Algebra 2 (Adelman, 2006). Similarly, districts with lower income levels are more likely to offer students less demanding content coverage (Schmidt et al., 2011). These types of results are especially disturbing due to the close association between enrollment in higher level mathematics courses and eventual academic attainment. “The highest level of mathematics reached in high school continues to be a key marker in precollegiate momentum, with the tipping point of momentum toward a bachelor’s degree now firmly above Algebra 2” (p. xix), with each additional mathematics class taken increasing the odds of earning a bachelor’s degree by approximately 2.5 times (Adelman, 2006).

Domina and Saldana (2012) also examined opportunities for course-taking in American education and found that since the National Commission on Excellence in Education published the report *A Nation at Risk* in 1983, the U.S. had indeed increased

academic rigor and expectations. These higher expectations included enrollment for more students in upper level mathematics courses, which helped reduce some of the enrollment gaps for students in different racial and social class groups. However, their findings also showed a “strikingly persistent” (p. 19) gap amongst higher level mathematics courses, such as Calculus, still remained. The importance of taking Calculus can be demonstrated by examining ACT’s policy reports concerning national and state trends on college- and career-readiness. ACT (2014b) reports that for the nation, 67% of students who had taken through Calculus in high school met the college- and career-readiness benchmarks. However, this number drops dramatically for students who made it only through Trigonometry, with only 30% of students meeting the benchmark score.

Few articles discuss socioeconomic status in isolation, and socioeconomic status and race are often at least partially interdependent. Many articles concern educational issues that are faced by both students that are minorities and also those of low socioeconomic status. “Several measures of teacher qualifications make clear that low-income and minority students have less contact with the best-qualified science and mathematics teachers” (Oakes, 1990, p. 10). State schools with high levels of low socioeconomic status and minority students are also more likely to experience teacher shortages and that the principals in these schools are less likely than other principals to be satisfied with the quality of their teachers and to consider them to be highly competent. Combining this with the issue that lower achieving students are often placed in classes with the least qualified teachers in the building, these students are now especially likely

to be with a lower qualified teacher than students in more advantaged schools (Oakes, 1990).

Along these same lines, research confirms while teacher quality always matters, it matters particularly for students in schools of low socioeconomic status where effective teachers are often distributed more unevenly. “To put it another way, in low-SES schools, it matters more which teacher a child receives than it does in high-SES schools” (Nye, Konstantopoulos, and Hedges, 2004, p. 254). Concerning the difference in the quality of teachers, there are instructional differences between more advantaged schools and those with large portions of disadvantaged, minority, and inner-city students. Teachers in these schools are less likely to emphasize the development of inquiry and problem solving skills, and they also vary in teaching methodologies, being less likely to encourage students to participate in active mathematics learning (Oakes, 1990).

School culture has also been shown to make a difference in mathematical achievement, though its affect is not uniform amongst the different racial groups. School organizational culture includes rituals, shared values, assumptions, climate, and behaviors, which are important because they help define how teachers interact between themselves and with students (Moller, Mickelson, Stearns, Banerjee, & Bottia, 2013). An important part of school culture is teacher perception of collaboration through strong professional learning communities. In the study by Moller et. al (2013) overall, low socioeconomic status African American students scored 13 points lower in achievement growth as compared to other low socioeconomic students in general. However, for students in schools where teachers claim a strong sense of professional community, the difference in achievement growth was only nine points. Conversely, for students with



teachers claiming a low sense of professional community, the gap was 18 points. The study also showed teacher sense of professional community was not as strong of a predictor for high socioeconomic students as it was for students of low socioeconomic status.

Race and socioeconomic status can seem, rather unfortunately, inextricably linked. While there have been multiple explanations of why minority students lag behind their White peers in terms of academic achievement, there seem to be three main factors (Sirin, 2005). These include minority students being more likely to live in low-income or single parent households, parents of minority students often having less education than White parents, and minority students being more likely to attend under-funded schools. All three of these factors are components of socioeconomic status and are linked to academic achievement through “interacting systems” (Sirin, 2005, p. 420).

Minorities are overrepresented amongst the lower income population (Sirin, 2005). However, the cause and effect relationship between the two factors is still unclear. “The weakness of SES as an explanatory factor for the Black-White gaps were revealed by the fact that in both 1990 and 1996, the lowest SES White students scored equal to or higher than the highest SES Black students” (Lubienski, 2002, p. 283). This seemed to be a common theme throughout the literature. Socioeconomic status-related factors can partially explain racial performance gaps, and race-related factors can partially explain socioeconomic performance gaps, but neither completely explains the other.

Another educational issue affected by both race and socioeconomic status is academic tracking. The placement of students on academic tracks in specific subjects

such as mathematics, and also in broader educational programs of study, has been widely examined by researchers and is rather complex. In a study examining the effects of tracking, Gamoran (1992) identifies several characteristics of school tracking systems. The characteristics included selectivity (as measured by the homogeneity created by school tracking systems), electivity (the extent to which students are able to select their own academic tracks), inclusiveness (the relative amount of students that are included in the college-preparatory academic track), and scope (the way students are tracked across subjects as opposed to tracking being more subject area specific). The results of the study confirmed, unsurprisingly, that membership in higher academic tracks is in fact associated with higher academic achievement. The effects of tracking also depended on the specific characteristics previously mentioned. For instance, the analysis showed achievement gaps between tracks in very rigid systems was wider than those in flexible ones. This gap was also larger when inclusiveness was either high or low but smaller when the inclusiveness of the system was more moderate. The research did not, however, provide support for Gamoran's hypotheses that higher selectivity would lead to larger differences in between-track achievement while leading to higher overall school achievement.

Other research explores the connection between socioeconomic status and the placement of students on academic tracks. Yonezawa, Wells, and Serna (2002) found even when institutions make an attempt at de-tracking their academic structure, it has been shown there are still barriers that prevent the hoped-for equity. In reference to the minority and low socioeconomic status students in a school that had attempted to de-track course structure, there still seemed to be reasons for these students to remain in lower

tracked classes. Possible reasons included feelings of inadequacy and desire to stay in the “safe spaces” (p. 59) of the more familiar classes, along with other school-based barriers including the uneven distribution of information concerning higher level courses and also “hidden prerequisites” (p. 59) enforced by educators helping students to choose their coursework. The authors concluded tracking systems continued to contribute to “within-school segregation” (p. 54), even when attempts were made to counteract the negative effects.

As shown, many educational issues that affect minority students also affect students of low socioeconomic status. Additionally, the literature shows one factor can influence the effect of the other. Sirin (2005) notes the effect of socioeconomic status can depend on race. Specially, it was found that SES was a stronger predictor for White students than it was for minorities. In the same article the author adds that socioeconomic status can vary in reliability as a predictor depending on how the information was collected. He writes information gathered from parents was the more accurate than that collected from children. Older children are able to provide more accurate reports than younger children, but both groups might provide misleading information either because they do not know or in an effort to conceal their family’s lack of resources.

Additionally, many researchers studying gender also agree that race and socioeconomic status should be considered at the same time. “Any report of gender differences in achievement would be incomplete without discussion of race/ethnicity and SES” (McGraw, et al. 2006, p. 140). Just as socioeconomic factors often influence the effect of race (and race influences socioeconomic effects), gender is a moderating factor

as well. In the 2000 NAEP data, gender gaps in achievement were most prevalent among White students of high socioeconomic status (McGraw et al., 2006). Hyde and Linn's 2006 study provides another example of how race can moderate the effect of gender. The authors found for U.S. students, the effect size of gender differences on mathematical performance was  $d = 0.13$  for White students,  $d = -0.02$  for African Americans,  $d = 0.00$  for Hispanic students, and  $d = -0.09$  for Asian American students.

In the last three sections, literature has been reviewed that concerned how socioeconomic status, gender, and race are associated with disparities in mathematical achievement. In the next section, interventions will be discussed that could possibly help close these gaps.

### **Interventions**

Whether researchers are examining achievement gaps caused by gender, race, or socioeconomic status, throughout the literature in this review, there were many ideas for interventions, both direct and indirect. Names of several specific programs were mentioned as possible solutions. "There have been many attempts to close the achievement gap. Early childhood interventions such as Head Start, Nurse-Family Partnership, and the Abecedarian Project boost kindergarten readiness, but the effects on achievement often fade once children enter school" (Dobbie and Fryer, 2009, p. 1). The Student Success Skills program (SSS) is also aimed at increasing student achievement by focusing on cognitive and metacognitive skills such as goal setting and progress monitoring, social skills such as teamwork and listening, and self-managing skills focusing on attention, motivation, and managing anger. While the program does help in increasing academic skills, especially for low- to mid-range academic achieving students,

White, Latino, and African American students all showed similar gains. This means the program was in fact helpful to students, but it did not do anything to close the achievement gap (Miranda, Webb, Brigman, & Peluso, 2007).

Also mentioned in the literature was a strategy that involved an intervention aimed at reducing the racial gap in academic achievement (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzuktoski, 2009). Students were asked to participate in brief but structured writing assignments focused on a self-affirming value. The authors claimed the program was successful, with participants' grade point averages rising around 0.24 points over the course of two years, with particular benefits demonstrated amongst low-achieving African American students whose grade point average increased by an average of 0.41 points along with showing a significant decrease in their rate of remediation or grade repetition (5% as compared to 18% for those not participating in the program). These self-affirmation exercises were thought to combat the negative influences of stereotypes concerning academic performance of minorities, and "the intervention's impact on students' psychological environment is indicated by data suggesting that it buffered African Americans against the impact of early poor performance on their long-term perceptions of adequacy" (Cohen, et al., 2009, p. 401). The researchers went on to claim this intervention was a way of closing achievement gaps since it helped low-achieving minority students while not showing much effect on White students who are less at risk for performing poorly under the threat of a perceived negative stereotype.

For closing what remains of the achievement gap for female students, much of the focus has been on raising awareness that these gaps are not as insurmountable as they had originally seemed. "To neutralize traditional stereotypes about girls' lack of ability and

interest in mathematics and science, we need to increase awareness of gender similarities. Such awareness will help mentors and advisers avoid discouraging girls from entering these fields” (Hyde & Linn, 2006, p. 600). Efforts should also be aimed at raising parental awareness of girls’ potential in mathematics, since student perceptions of their own skills are often more heavily influenced by their parent’s perceptions than their actual performance (Niederle & Vesterlund, 2010).

Another method touted for its ability to close achievement gaps is formative assessment. The use of formative assessment means teachers would utilize assessment not just as a measure of student success but as feedback that could provide guidance pertaining to instruction. The use of formative assessment, while raising achievement for all students, is particularly effective for lower-achieving students, thus helping to close performance gaps. In order for these assessments to be effective they must provide accurate reflections of student achievement, frequent descriptive feedback, and have a clear purpose that allows students to be involved in the assessment process (Stiggins & Chappuis, 2005).

Within schools, much of the focus on interventions to close achievement gaps has been placed on Response to Intervention (RTI) strategies, called a “systems change initiative that can comprehensively address the diverse academic and behavior needs of all students...” (Sansosti, Noltemeyer, & Goss, 2010, pp. 286-287). The implementation of RTI strategies is meant to increase academic achievement through frequent progress monitoring gauging the need for academic and behavior interventions. However, there are currently numerous barriers to the implementation of RTI strategies, especially at the secondary level. These include a lack of evidence-based interventions, few systematic

data collection systems, and scheduling concerns including allowing teachers time to work with the students who demonstrate a need for additional help (Sansosti et al., 2010).

There are also interventions that attempt to address achievement gaps caused more specifically by socioeconomic status. As discussed previously, these students often enter school disadvantaged because of a lack of social resources at home. Because of the positive association between a parent's active role in their child's education and student learning, educational organizations often design methods specifically to help parents become involved in their child's learning experiences both at home and school (Schlee et al., 2009). Other researchers have looked at the effects of school-level socioeconomic status. For example, research has shown there is more variation of the quality of teachers in lower income schools, meaning replacing less effective teachers with those who are more effective, or helping less effective teachers become more skilled, would be a particularly effective method for closing the achievement gap in these schools (Nye et al., 2004).

Other articles have looked at the problem of closing achievement gaps in a more general way. In his 2009 article, Murphy claimed attempts to change school reform policies such as those concerning school choice are backed with very little evidence student learning will be affected and claimed there is no "magic elixir" (p. 10) that will close the achievement gap. He does go on to provide a list of "principles of work" or "cautionary rules of thumb" (p. 12) to help reduce differences in levels of achievement. These include, amongst many others, the ideas that interventions must disproportionately advantage lower-achieving students rather than all students, that an integrative approach is more likely to work than isolated actions, that the prevention of gaps is always better

than trying to make up for them, that no short term solutions are going to close achievement gaps, and that no “silver bullet” (p. 12) is going to fix the problem.

Closing achievement gaps will not be easy, no matter what their cause. Research on the topic is extensive, and yet not far reaching enough to provide many concrete ideas for fixing the problem. In the next section of this literature review, gaps in existing research will be discussed along with ways the current study helped address them.

### **Gaps in the Literature Concerning Possible Interventions**

Most of the literature provided evidence of, and possible reasons for, academic underachievement as evidenced by scores on exams such as the one administered as part of the NAEP. While there was some reference to school indicators of success, there was not much mention of specific academic outcomes such as the failure of classes like Algebra I and/or Geometry. Interventions discussed in the literature were often focused on the broad manifestations of achievement gaps and were aimed at closing these gaps and preventing failure before it occurred. These are inarguably worthwhile goals and the prevention of failure is certainly preferable to having to find a solution once it occurs. However, student failure of these classes is likely to remain a problem which schools will have to face. This study will contribute knowledge concerning specific interventions aimed at helping these students reach success. Most of the options examined in the study, such as re-taking classes, summer school, and online options, are commonly used and would be of wide interest to educators in secondary schools.

In their 2011 position statement concerning intervention, the NCTM calls for using “increasingly intensive and effective instructional interventions for students who struggle in mathematics” (para. 1). They call for teachers who have strong backgrounds



in not only mathematics but mathematical content knowledge for teaching, and also those who implement a wide range of instructional strategies and formative assessments. Providing carefully chosen credit recovery options might be one way educators can help these struggling students. By delving deeply into the academic outcomes of credit recovery options on college- and career-readiness, while also taking into account other student factors such as race, socioeconomic status, and gender, this study aimed to increase the research knowledge base concerning the types of interventions called for by NCTM.

### **Current Credit Recovery Options**

This section focuses on the credit recovery options offered to students in Kennlee County since 2008, when Kentucky began administering the ACT to all high school juniors. The options included: re-taking a course in a traditional classroom setting, completing an online credit recovery course (Plato), taking the course in summer school, and a mastery based class offered in the morning before school referred to as Zero Hour.

#### **Re-taking a Course.**

One option for students who do not successfully complete a class is to re-take it the following year. In earlier years, if a student failed Algebra I, they might re-take it their sophomore year, take Geometry their junior year, and then complete Algebra II as a senior. However, with changing graduation and assessment requirements, this is now far less common. Kentucky now requires students to complete Algebra II in order to graduate, and schools are less likely to allow students to take this course for the first time during their senior year. If all students take Algebra II by the time they are juniors, they will have another year to make up the credit in case they are unable to finish the course

successfully. Also, there is a large portion of mathematical content on the ACT that is not covered until Algebra II. Teachers and administrators do not want juniors to take the ACT, with the scores an important portion of the school's accountability index, if they have not had a chance to learn the material. Instead, schools often require students who have failed a course to enroll in two mathematics classes, such as re-taking Algebra I while also enrolled in Geometry their sophomore year. Though in the past there have been classes specifically allocated for "repeaters," schools often enroll these students in regular Algebra I or Geometry courses.

**Plato.**

Plato is a company that offers online credit recovery courses. The company originally focused on remedial instruction in basic mathematics and literacy skills, but moved towards credit recovery in a five-year transition period from 2001 to 2006 (Trotter, 2008). According to the company's website, "Plato Courseware is a standards-based online learning program grounded in a tradition of solid research, sound pedagogy, and applied innovation. We develop rigorous, relevant curriculum that challenges your students with a 21st century approach - engaging them with interactive, media-rich content." Each Plato course is divided into separate lessons. Within a lesson, there is a tutorial, a set of practice questions, and then a test. Students must show mastery of at least 80% of the content for each individual lesson. After completing all lessons, students must take a cumulative exam covering the content from that course. Previously, this was a paper-and-pencil test written by Kennlee County to reflect the course content. More recently, the district has begun using the newly issued exam created by Plato taken online. If students fail this online test, they are required to re-take the tutorials over

content for which they did not demonstrate mastery, and are then allowed to take the test again.

Plato is used in several ways in Kennlee County. Some students who are enrolled in Plato courses attend sessions after school in computer labs. There is a teacher assigned to the room to supervise and occasionally help students with content questions. Some schools allow students to go to the computer lab during the school day, as they spend one of their class periods making up credit from courses they have failed. Another way Plato is used is during the summer. In an upcoming section, more traditional summer school is discussed. In some cases, though, schools will hire a teacher to be in the computer lab for a few weeks in the summer to supervise and assist with questions. Other students are enrolled in Plato and do their coursework from their homes. Plato courses are written so that students may work independently and earn their credit. However, many of them find it is useful to take advantage of opportunities to work in the school computer lab when there is a teacher available for questions.

### **Summer School.**

While some students complete Plato during the summer, other summer school options are more traditional. Often, summer school courses last for about 2 weeks with class held only in the morning, providing about 40 hours of instruction. The class is designed to be a repeat of the school year course in miniature. Teachers attempt to recover all (or nearly all) of the material the students would see normally, but much more quickly. The hope is that these students did in fact learn a fair amount of the material during the school year, even though they did not earn a passing grade, and thus would be prepared for being able to master the content more quickly than is expected the first time

they take the class. Because of time conflicts, students who failed more than one class are usually only able to make up part of their missing credits during summer school.

It is important to note that for the purpose of this study, “summer school” refers to these classes-in-miniature, not participating in Plato during the summer months. Data for those students will be included with the group of students who completed Plato during the regular school year.

### **Mastery Based Learning Program.**

This study also examined one other credit recovery option which is not as commonly offered as Plato or summer school might be. Students participated in the program for between two and four weeks depending on their skill level. Classes were held in the morning before school and last for 45 minutes, with the class being commonly referred to as “Zero Hour” due to its early start time. Students enrolled in the class earned credit by successfully passing the final exam given to Algebra I classes the previous school year. Once students passed the exam, they were given a 65% D in the course, the lowest possible passing grade in Kennlee County. Students studied with the teacher for two weeks and took the final exam. Any student who passed the exam was done with the course and their grade for the semester was changed. Students who did not pass the test were given another chance after one week of additional study. They only re-took questions on the final exam they missed on the first attempt. The teacher gave them a study guide, indicating which questions they missed and needed to continue to work on. When the student took this second test, the number of correct answers from both tests were added, and any student whose score now over 65% earned a passing grade for the course. Often times, there are only a few students who do not pass the test by this second

attempt. They continued to study the questions they missed and were given one final try. Because the class size had been drastically reduced, the students still in the program were given a tremendous amount of personalized attention. Since the program began in 2010, approximately 200 students successfully earned their Algebra I credit attending Zero Hour. No student who attended and took the exam all three times failed to successfully complete the course.

### **Conclusion**

The literature indicates that college- and career-readiness is a worthy goal, and that mathematics plays an important role, perhaps especially early in students' high school years when they take courses such as Algebra I and Geometry. Additionally, special attention must be paid to students who fail these important classes, as they are struggling learners and are at particular risk for not meeting the ACT benchmark scores indicating college- and career-readiness. Schools must provide remediation options to these students, and these can include programs such as summer school, Plato, re-taking the class, or less traditional options such as Zero Hour. The literature also demonstrates that attainment of any educational goal is complicated, and student characteristics such as gender, race, and socioeconomic status can all play a role. The data analysis for this study took these factors into account, and the methodology and findings are presented in the next two chapters.

## **CHAPTER III: Methodology**

The purpose of this study was to analyze the role of four credit recovery options used to allow students in one high school to make up their credit after having failed Algebra I and/or Geometry, along with examining what student characteristics (such as race, gender, and socioeconomic status) influence ACT mathematics scores.

### **Research Questions**

The research questions addressed by the study were:

1. Which credit recovery option (Plato, summer school, re-taking a course, or Zero Hour) is most closely associated with student ability to meet the college- and career-readiness benchmark score of 19 on the mathematics portion of the ACT taken in the spring of their junior year?
2. To what extent do student characteristics such as race, gender, and socioeconomic status explain variability in ACT scores for students who have failed Algebra I and/or Geometry?

### **Research Design**

The independent variable in the study was categorical data indicating which credit recovery option the student participated in. The four options examined were re-taking the class, summer school, Plato (an online course taken individually), and a mastery based course commonly called Zero Hour. It is important to understand that the options participated in by students were not randomly assigned. Decisions regarding the method used to make up credit were made on a case-by-case basis, often determined by the counselor, parent(s), and the student themselves. The dependent variable in the study was student score on the mathematics portion of the ACT taken in the spring of students'

junior year. Discussion concerning how these scores align with college- and career-readiness and Kentucky's use of benchmark scores can be found in the literature review of this study. The covariates in this study included gender, race, and socioeconomic status. These three are amongst the most commonly used factors in educational research (Tate, 1997; Grant & Sleeter, 1986) and the literature review section of this study provides additional information about how each play an important role in mathematical performance. Several other measures of individual student characteristics were also collected. The analysis included a measurement of how many total semesters of Algebra I or Geometry individual students failed, as it was thought that students who fail only one semester of a class might differ in some important way than students who go on to fail both. Also, as a measurement of previous student achievement, scores from the mathematics portion of the PLAN test, administered to students in the fall of their sophomore year, were used in the analysis. This exam was chosen because it was the most recent high-stakes mathematics exam given to these students previous to taking the ACT, and additionally the PLAN has a close alignment to the ACT as they are both given by the same testing company with documentation provided by the company on how to use the PLAN exam to predict future ACT scores. In summary then, type of credit recovery option participated in, student characteristics gender, race, and socioeconomic status, and prior achievement data were the factors examined by this study to determine their role in ACT mathematics scores and attainment of college- and career-readiness benchmarks

## **Data**

Data was collected from the school district's Office of Data Research and Evaluation (DRE). Students included in the original sample set were those who failed Algebra I and/or Geometry at one of the district's high schools. The high school used in the study was chosen because it was found to have the most accurate data keeping procedures in relation to noting how students made up credit, and it also had the most varied programs, giving students multiple options for how they made up their class. While other high schools in the district only allow students to either re-take the class in the traditional setting or make up their credit using Plato, the high school in the study offered the two additional options of summer school (offered for both Geometry and Algebra I) and the mastery based program Zero Hour (only offered for Algebra I).

The study examined how credit recovery options affect student achievement as measured by ACT mathematics scores. Therefore, any student who did not make up their credit until after taking the ACT in the spring of their junior year was deleted from the data set. A primary research question of this study concerned factors that played a role in the attainment of college- and career-readiness benchmark scores, including race, gender, socioeconomic status, and previous achievement. Of course, another important factor in a student's educational experience is their teacher, and the effect of the teacher the child had for the failed course was considered in the analysis. While most of the students who failed multiple semesters of a course had the same teacher both times, a few cases were found in which the student had one teacher for the fall semester, and a different teacher for the spring semester. Because it would be very difficult, if not impossible, to differentiate the effects of the two different teachers, these cases were



deleted from the data set. Similarly, it was found that most students who failed multiple semesters used the same credit recovery option to make up both semesters. Again, though, a few cases were identified in which the student used one method to make up the fall semester and a different method to make up the spring semester. Because of the same difficulty in differentiating the effects of two different credit recovery options, these students were also deleted from the data set. This was a non-issue, of course, for students failing only one semester since they came from only one teacher and used only one credit recovery option.

The data set analyzed, then, included students who had the same teacher for any semester of Algebra I or Geometry they failed and the analysis for Algebra I and Geometry were run and analyzed separately. Student gender was dummy coded, as was students' socioeconomic status indicated by eligibility for the free/reduced lunch program. Information pertaining to student race in the data set provided from the school district included categorization as White, African American, Hispanic, Asian, and "Other." It was decided that only the effects of being White, African American, and Hispanic were to be analyzed as the other two groups had far fewer students. A variable indicating the number of semesters the students failed Algebra I or Geometry respectively was grand mean centered, as were student scores from the mathematics portion of the PLAN exam taken in the fall of sophomore year. These PLAN scores were missing for some students, and pair-wise deletion was used in the analysis.

### **Data Analysis**

As the data in this study was nested as students from within teachers, analysis was performed using hierarchical linear modeling (HLM). HLM offers several advantages

over other possible statistical procedures. HLM takes into account that individuals within groups might be more similar to each other than individuals in other groups. These similarities mean there can be no assumption of independence between the individuals. HLM allows for the explicit modeling of individual and group residuals, taking into account individuals' interdependence within the same group (Hofmann, 1997). Because students who have the same teacher will have some important factors in common (such as classroom expectations, amounts of homework, teacher experience level, and teaching methodologies), it is plausible they are more likely to have similar outcomes than students who have different teachers. HLM allows for the exploration of fixed effects (average impacts of variables such as gender, race, and socioeconomic status on ACT mathematics scores) and also random effects (how the impact of those same variables might vary across the teachers the students had for the failed course).

HLM is an extension of more basic linear models, and therefore the assumptions are very much the same (Fields, 2009). Osborne and Waters (2002) provide a list of assumptions to be tested concerning linear regressions. First is the normal distribution of variables. Relationships that are highly skewed or with substantial outliers can result in distorted relationships and significance tests. Next, the assumption of a linear relationship between the independent variable and dependent variable should be tested, with one possible method being the examination of residual plots. Also tested should be the assumption of homoscedasticity, the variance of errors being the same across all levels of the independent variable. Additionally, the reliability of the variables should be checked by examining the reliability estimates.

Because students having the same teacher for a failed course are more alike than students having different teachers, a 2-level hierarchical linear model was appropriate for the analysis of the study data, with level-1 concerning student data and level-2 concerning the teachers the students had for the failed course. Student participants were identified by Kennlee County as those students at the chosen high school who failed Algebra I or Geometry from school years 2008-2009 through 2012-2013. This data included, as the independent variable in the study, which credit recovery option the student participated in, along with their gender, race, and socioeconomic status as indicated by participation in the free/reduced lunch program, PLAN mathematics score, and the number of semesters of Algebra I and/or Geometry failed. The level-2 data is the teacher the student had for the Algebra I or Geometry class they failed. Because of confidentiality concerns, no additional information was collected about the teacher. The implications of this lack of teacher-level data can be found in the discussion chapter of this study.

The following is a description of the statistical model that was used in the analysis.

The two levels presented in this model are:

$i$  = student

$j$  = teacher

$Y_{ij}$  is the outcome (ACT mathematics portion score) for student  $i$ , who had teacher  $j$  for the Algebra I or Geometry class they failed.

There are six level-1 predictors:

$a_1$  (gender)

$a_2$  (socioeconomic status)

$a_3$  (race)

$a_4$  (PLAN mathematics score)

$a_5$  (number of semesters failed)

$a_6$  (credit recovery option participated in)

The level-1 model is:

$$Y_{ij} = \pi_{0j} + \pi_{1j} \cdot a_{1ij} + \pi_{2j} \cdot a_{2ij} + \pi_{3j} \cdot a_{3ij} + \pi_{4j} \cdot a_{4ij} + \pi_{5j} \cdot a_{5ij} + \pi_{6j} \cdot a_{6ij} + e_{ij}$$

$\pi_{0j}$  is the intercept,  $\pi_{1j}$  is the slope for gender,  $\pi_{2j}$  is the slope for socioeconomic status,  $\pi_{3j}$  is the slope for race,  $\pi_{4j}$  is the slope for PLAN mathematics score,  $\pi_{5j}$  is the slope for number of semesters failed, and  $\pi_{6j}$  is the slope for the credit recovery option participated in.  $e_{ij}$  is the random effect for student  $i$  with teacher  $j$ , which is normally distributed with a mean of zero and a variance  $\sigma^2$ .

The level-2 predictor is the teacher,  $X_{teacherj}$ . To build the level-2 model, the intercept ( $\pi_{0j}$ ) and slopes ( $\pi_{1j}, \pi_{2j}, \pi_{3j}, \pi_{4j}, \pi_{5j}, \pi_{6j}$ ) are treated as outcomes to be predicted.

$$\text{Equation 0: } \pi_{0j} = \beta_{00} + \beta_0 \cdot X_{teacherj} + r_{0j}$$

$$\text{Equation 1: } \pi_{1j} = \beta_{10} + \beta_1 \cdot X_{teacherj} + r_{1j}$$

$$\text{Equation 2: } \pi_{2j} = \beta_{20} + \beta_2 \cdot X_{teacherj} + r_{2j}$$

$$\text{Equation 3: } \pi_{3j} = \beta_{30} + \beta_3 \cdot X_{teacherj} + r_{3j}$$

$$\text{Equation 4: } \pi_{4j} = \beta_{40} + \beta_4 \cdot X_{teacherj} + r_{4j}$$

$$\text{Equation 5: } \pi_{5j} = \beta_{50} + \beta_5 \cdot X_{teacherj} + r_{5j}$$

$$\text{Equation 6: } \pi_{6j} = \beta_{60} + \beta_6 \cdot X_{teacherj} + r_{6j}$$

$\beta_{00}, \beta_{10}, \beta_{20}, \beta_{30}, \beta_{40}, \beta_{50},$  and  $\beta_{60}$  are level-2 intercepts, and  $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5,$  and  $\beta_6$  are level-2 slopes.  $r_{0j}, r_{1j}, r_{2j}, r_{3j}, r_{4j}, r_{5j},$  and  $r_{6j}$  are random effects for teacher  $j$ .

The effects of credit recovery options and student characteristics were all analyzed separately, both as fixed and random effects, meaning each variable was examined to determine if it was associated with an average effect on student ACT mathematics scores and then also to see if the effects of this variable varied across the teachers the students had for the failed course. Once these were examined separately, the variables that had been found to be statistically significant were analyzed in a single

model. Variables no longer found to be statistically significant were deleted from the model, beginning with random effects and then fixed effects. The final models, one for Algebra I and one for Geometry, were determined once all variables remaining in the model were statistically significant. The results of these final models are discussed in the next chapter of this study.

## CHAPTER IV: RESULTS

Two separate analyses were run in this study, one for students who had failed Algebra I and another for students who had failed Geometry. For each analysis, the descriptive statistics can be found below. Also included in this chapter are descriptions of the process used to find the final model for each data set, along with the statistical results from each model.

### **Data Set for Algebra I**

The first data set analyzed contained students who had failed Algebra I between the school years of 2008-2009 and 2012-2013. The original data obtained from Kennlee County contained a group of  $N = 478$  students. Unfortunately, large portions of the data then had to be deleted from the data set for several reasons. Some students were found to have left Kennlee County before making up their Algebra I credit. Possible reasons included simply moving to another school district ( $n = 130$ ) or dropping out of high school altogether ( $n = 52$ ). Additionally, some students in the data set were found to simply never had made up their credit ( $n = 53$ ). While it was impossible to determine from the data provided by the county why this was the case, one possibility is that these were the younger students in the data set who had not made up the credit before this data was obtained, though they might in the future. An additional set of students ( $n = 20$ ) did make up their Algebra I credit, but did not do so until after the junior year administration of the ACT. As this study examined the role of a credit recovery option on ACT scores, the data from these students would not be able to provide useful information, and was thus deleted. Some students ( $n = 59$ ) were also found to have made up their credit at another school or program in Kennlee County. Since this study examined credit recovery

options at only one high school (ensuring treatments were administered as uniformly as possible), these students also were deleted from the data set. Yet another group ( $n = 164$ ) could not be used in the analysis because they had no ACT score, the dependent variable in the study. It is important to note, though, that these group numbers include overlap. Many students who would need to be deleted for one reason (such as missing ACT scores), might already have been deleted for another reason (like never making up their Algebra I credit). Even considering these populations did overlap, these deletions significantly reduced the sample size of the population and implications and recommendations concerning these issues are discussed in the last chapter of this study. Finally, a few final students were deleted because they had failed multiple semesters of Algebra I and either had different teachers for the two semesters ( $n = 5$ ) and/or used different credit recovery options to make up the class ( $n = 11$ ). As mentioned in the methodology section of this study, it would not be possible to differentiate the effects of two different teachers or two different credit recovery options, and thus these students ( $n = 13$ , considering some overlap in the two groups) were deleted. After all deletions, the sample of students to be analyzed was left at  $n = 95$ .

### **Data Analysis for Algebra I**

Once the final set of usable data was found, all variables were coded as described in the methodology section in this study, and the descriptive statistics can be found below in Table 4.1 for categorical data and Table 4.2 for continuous data. One variable was the credit recovery option used, and included summer school, Plato, Zero Hour, and re-taking the class in a traditional classroom setting. Other dummy coded variables included gender and socioeconomic status (indicated by eligibility for the free/reduced lunch

program). Race was dummy coded for identification as being White, African American, or Hispanic, with students of some “other” race used as the baseline category. Data concerning student PLAN mathematics score and also a variable that described the total number of semesters of Algebra I the student failed were both grand mean centered for data analysis. The outcome variable for the study was ACT mathematics score. Finally, students were grouped by which teacher ( $n = 18$ ) they had for the failed semester(s) of Algebra I to accommodate the data hierarchy. As discussed in the Methodology section, students who had the same teacher for the failed course were more alike than those under other teachers. Therefore, the nesting structure of this study was a 2-level one, with student data being level-1, and which teacher they had for the failed course being level-2.

Table 4.1

*Descriptive Statistics for Categorical Student Level Variables-Algebra I*

	<i>Frequency</i>	<i>%</i>
Credit Recovery Option		
Plato	8	8.4
Summer School	28	29.5
Re-Take Class	16	16.8
Zero Hour	43	45.3
Gender		
Male	49	51.6
Female	46	48.4
Race		
African American	37	38.9
Hispanic	10	10.5
White	43	45.3
Other	5	5.3
SES		
Free/Reduced Lunch	64	67.4
Non-Free/Reduced Lunch	31	32.6
Number of Semesters Failed		
One	76	80.0
Two	19	20.0



Table 4.2

<i>Descriptive Statistics for Continuous Student Level Variables-Algebra I</i>					
	<i>n</i>	Minimum	Maximum	<i>M</i>	<i>s.d.</i>
PLAN Mathematics Score	82	10	23	15.30	2.095
ACT Mathematics Score	95	13	25	16.06	2.128

### Statistical Results for the Null Model.

Using HLM 7 software, a null model was run with the following structure, and statistical results can found in Table 4.3.

Level-1 Model:

$$ACTMATH_{ij} = \beta_{0j} + r_{ij}$$

Level-2 Model:

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

Table 4.3

<i>Results from the Null Model of Teacher Effects on ACT Mathematics Scores-Algebra I</i>				
Fixed Effects				
	Coefficient	<i>SE</i>	t-ratio	<i>p</i>
Intercept (ACT Mathematics score) $\gamma_{00}$	16.08	.23	71.45	< .001
Random Effects				
	Variance	<i>df</i>	Chi-Square	<i>p</i>
Between-teacher variability (Intercept) $\tau$	.09	17	19.78	.285
Within-teacher variability $\sigma^2$	4.45			
Reliability (Intercept)		.091		
Intraclass Correlation		.020		

The mean ACT score was found to be 16.08, and was statistically significant.

The variance at the student level ( $\sigma^2$ ) was found to be 4.45 and the variance at the teacher level ( $\tau$ ) was found to be .09, though it was not found to be statistically significant.

Intraclass correlation, calculated by dividing level-2 variance by total variance was found

to be .020. This means 2.0% of variance in ACT mathematics score could be attributed to the teacher the student had for Algebra I and 98% could be attributed to individual students. The reliability was found to be quite low (.09) meaning teachers could not be “easily” separated according to students’ ACT scores.

### **Statistical Results for the Full Model.**

Once the null model was found, effects of the different credit recovery options and student characteristics were analyzed. The effects of the four credit recovery options (Plato, summer school, re-taking the course, and Zero Hour) and student level characteristics (number of semesters failed, gender, PLAN mathematics score, along with whether students were African American, Hispanic, or White, and eligibility for free/reduced lunch) were each added to the null model separately. A model was run for each of the above variables as a fixed effect to determine if it had an average impact on student ACT mathematics scores. Another model was run considering it a random effect to determine if the impact of the predictor varied across the teachers the students had for the failed semester(s) of Algebra I. The variables found to be statistically significant as fixed effects were participation in summer school, number of semesters failed, gender, PLAN mathematics scores, and identification as African American. The variables found to be statistically significant as random effects were participation in Plato, re-taking the course, PLAN mathematics score, and identification as White. Participation in Zero Hour, student identification as Hispanic, and eligibility for the free/reduced lunch program were not statistically significant as either fixed or random effects.

A model was then run with those variables found to be statistically significant, listed above. PLAN mathematics score had been found to be statistically significant as

both fixed and random and was run in this model as a random effect. Variables were then deleted based on largest  $p$ -values, beginning with random effects. Plato and PLAN mathematics scores both had  $p$ -values  $p > .500$ . Plato was first deleted from the model, as it had the smaller variance component, keeping in mind Plato was not statistically significant as a fixed effect. Once Plato was deleted, all random effects were found to be statistically significant. Moving on to fixed effects, the variable indicating a student was African American ( $p = .931$ ), the variable indicating participating in summer school ( $p = .352$ ), the variable indicating the number of semesters failed ( $p = .179$ ) and finally the variable for gender ( $p = .125$ ) were all deleted sequentially from the model in that order. This left a model in which all variables were found to be statistically significant, with re-taking the class, PLAN mathematics score, and identification as White all random effects. In the combined model, no student characteristics nor participation in any credit recovery option was found to be statistically significant as a fixed effect. The following is the combined model, with statistical results found in Table 4.4. Because of the presence of random effects,  $R^2$  is not provided.

### **Level-1 Model**

$$ACTMATH_{ij} = \beta_{0j} + \beta_{1j}*(PLANMATH_{ij}) + \beta_{2j}*(RE_{ij}) + \beta_{3j}*(WH_{ij}) + r_{ij}$$

### **Level-2 Model**

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + u_{3j}$$

Table 4.4

*Results of the Combined Model-Algebra I*

	Fixed Effects			
	Coefficient	SE	t-ratio	p
Intercept (ACT Mathematics score) $y_{00}$	15.67	.22	72.70	< .001
Student Level Variables				
PLAN Mathematics Score $y_{10}$	.43	.12	3.67	.002
Re-Taking Class $y_{20}$	.53	.70	.80	.439
Identification as White $y_{30}$	.13	.28	.46	.653
	Random Effects			
	Variance	df	Chi-Square	p
Between-teacher variability (Intercept) $\tau$	.263	3	8.41	.037
Student Level Variables				
PLAN Mathematics Score $y_{10}$	1.224	3	10.03	.018
Re-Taking Class $y_{20}$	2.595	3	13.20	.005
Identification as White $y_{30}$	.243	3	7.69	.052
Within-teacher variability $\sigma^2$	1.220			

The above model demonstrates there are no fixed effects for re-taking Algebra I, PLAN mathematics score, or being classified as White, meaning on average, we would expect no impact of any of those factors on ACT mathematics score. However, all three were found to be statistically significant as random effects, meaning the effect of each of these varied across the teachers the students had for Algebra I. For example, we would expect no impact, on average, resulting from students re-taking Algebra I in the traditional classroom setting. However, because re-taking Algebra I was found to be statistically significant as a random effect, we would expect that the effects of re-taking Algebra I will vary across the teachers the students had originally for the course. This means some teachers are more effective than others in preparing their students for this remediation option in terms of ACT mathematics scores. Implications of these findings are explored further in the Discussion section of this study.

## Data Set for Geometry

The second data set analyzed was for students who had failed Geometry in those same years of 2008-2009 to 2012-2013. These students attended the same school that was analyzed for the Algebra I data. As was the case with the Algebra I students, the original data set obtained from the district contained many students who had to be deleted for various reasons. The original data set contained  $N = 453$  students. Some students were deleted because they had left the district before making up their Geometry credit, either because they moved to another school district ( $n = 77$ ) or dropped out of school ( $n = 78$ ). Another group ( $n = 69$ ) was found to have never made up their Geometry credit. Similarly to those students in the Algebra I data set who had never made up their credit, it was not possible to tell from the data why these students had never made up Geometry but perhaps these students just had not made up their credit by the time the data was obtained and will make it up later. An additional group of students ( $n = 68$ ) were deleted because they did not make up their Geometry credit until after taking the ACT, meaning no matter what remediation option they used, it would not have impacted their performance on the ACT. Also deleted from the data set were students ( $n = 79$ ) who made up their Geometry credit at another school or program in Kennlee County. Next, a set of students was deleted from the data set ( $n = 85$ ) because they had no ACT scores. Finally, two students were deleted because they had two different teachers for their two failed semesters of Geometry, one student was deleted because they used different options for their two failed semesters, and one student had both different teachers and used different options. For all four of these students, it would have not have been possible to differentiate the impact of different teachers and/or credit recovery options on

the students' ACT scores. However, similar to the data for Algebra I, these sets of deleted students overlapped, and after all deletions were made, the sample size was left at  $n = 86$ .

### **Data Analysis for Geometry**

The variables for the final set of data were coded as described in the methodology section and descriptive statistics can be found in Table 4.5 for categorical data and Table 4.6 for continuous data. It is important to note the only three credit recovery options offered to Geometry students were re-taking the class, Plato, and Summer School, with the mastery based program, Zero Hour, not an option. Variables were created for those three programs, gender was dummy coded, and another variable was dummy coded to indicate eligibility for the free/reduced lunch program. Similar to the data set for Algebra I, race was dummy coded for whether students were White, African American, or Hispanic, with only  $n = 6$  students being some "other" ethnicity and considered to be a baseline category. Data for PLAN mathematics scores and a variable indicating the total number of failed semesters of Geometry failed were both grand mean centered for data analysis. The outcome variable was ACT mathematics score, and students were grouped by which teacher ( $n = 10$ ) they had for the failed semester(s) of Geometry. This was to accommodate the study's data hierarchy as the nesting structure is again based on the assumption students who had the same teacher for the failed course are more alike than those who had different teachers, with level-1 data concerning student characteristics and level-2 being the teacher they had for the failed course.

Table 4.5

*Descriptive Statistics for Categorical Student Level Variables-Geometry*

	<i>Frequency</i>	<i>%</i>
Credit Recovery Option		
Plato	25	29.1
Summer School	18	20.9
Re-Take Class	43	50
Gender		
Male	44	51.2
Female	42	48.8
Race		
African American	39	45.3
Hispanic	7	8.1
White	34	39.5
Other	6	7.0
SES		
Free/Reduced Lunch	48	55.8
Non-Free/Reduced Lunch	38	44.2
Number of Semesters Failed		
One	64	74.4
Two	22	25.6

Table 4.6

*Descriptive Statistics for Continuous Student Level Variables-Geometry*

	<i>n</i>	<i>Minimum</i>	<i>Maximum</i>	<i>M</i>	<i>s.d.</i>
PLAN Mathematics Score	81	8	21	14.26	2.333
ACT Mathematics Score	86	13	26	15.84	2.114

### Statistical Results for the Null Model.

Using HLM 7 software, a null model was run with the following structure, with statistical results found in Table 4.7.

Level-1 Model:

$$ACTMATH_{ij} = \beta_{0j} + r_{ij}$$

Level-2 Model:

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

Table 4.7

*Results from the Null Model of Teacher Effects on ACT Mathematics Scores-Geometry*

Fixed Effects				
	Coefficient	SE	t-ratio	<i>p</i>
Intercept (ACT Mathematics score) $y_{00}$	15.84	.15	105.11	< .001
Random Effects				
	Variance	<i>df</i>	Chi-Square	<i>p</i>
Between-teacher variability (Intercept) $\tau$	.001	9	6.729	> .500
Within-teacher variability $\sigma^2$	4.467			
Reliability (Intercept)		.002		
Intraclass Correlation		.0003		

The mean ACT score was found to be 15.84, and was statistically significant. The variance at the student level ( $\sigma^2$ ) was found to be 4.467 and the variance at the teacher level ( $\tau$ ) was found to be .001 though it was not statistically significant. The Intraclass Correlation, calculated by dividing level-2 variance by the total variance was found to be .0003. This means 0.03% of the variance in ACT mathematics score could be attributed to the teacher the student had for Geometry and 99.97% could be attributed to individual students. As was the case for the Algebra I data analysis, there was a lack of statistically significant variance at the teacher level and reliability was quite low (.002), again indicating teachers were not easily separated according to student ACT scores.

### **Statistical Results for the Full Model.**

The process for finding the student level model was the same as that for analyzing the Algebra I data. The effects of the three credit recovery options (Plato, summer school, and re-taking the class) and then student characteristics (number of semesters failed, gender, PLAN mathematics score, along with whether students were African



American, Hispanic, White, and eligible for free/reduced lunch) were each added to the null model separately. A model was run for each of the above variables as a fixed effect to determine if it had an average impact on ACT mathematics scores, and another model was run considering it a random effect to determine if its impact varied across the teachers the students had for the failed semester(s) of Geometry. The only variable found to be statistically significant as a fixed effect was the variable indicating a student was African American. Found to be statistically significant as random effects were the variable indicating students had re-taken the class, the variable indicating participation in summer school, the variable indicating eligibility for free/reduced lunch program, and also PLAN mathematics score. Participation in Plato, the variable indicating the total number of semesters of Geometry failed, gender, and the variables indicating students were White and also Hispanic were found not to be statistically significant as either fixed or random effects.

A model was run with the random variables for re-taking the class, summer school, PLAN mathematics score, and eligibility for free/reduced lunch and the fixed variable indicating the student was African American. Variables were then deleted sequentially based on the largest  $p$ -values, beginning with random effects. The variable indicating eligibility for free/reduced lunch was deleted ( $p = .201$ ), and once the model was run again, the variable for PLAN mathematics score ( $p = .160$ ) had the largest  $p$ -value and was deleted. Once the model was run without those two variables, all  $p$ -values were found to be statistically significant and the final model was identified. In this final model, participation in summer school and re-taking the class were both found to be statistically significant as random effects, and student identification as African American

was found to be statistically significant as a fixed effect. The following is the combined model, with statistical results found in Table 4.8. As was the case for the Algebra I data analysis,  $R^2$  is not presented due to the presence of random effects.

**Level-1 Model**

$$ACTMATH_{ij} = \beta_{0j} + \beta_{1j}*(RE_{ij}) + \beta_{2j}*(SUMMER_{ij}) + \beta_{3j}*(BLK_{ij}) + r_{ij}$$

**Level-2 Model**

$$\beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + u_{3j}$$

Table 4.8

*Results of the Combined Model-Geometry*

Fixed Effects				
	Coefficient	SE	t-ratio	p
Intercept (ACT Mathematics score) $\gamma_{00}$	16.63	.48	34.49	< .001
Student Level Variables				
Re-Taking Class $\gamma_{10}$	-.54	.64	-.85	.419
Participation in Summer School $\gamma_{20}$	1.19	1.45	.82	.436
Identification as African American $\gamma_{30}$	-1.07	.08	-14.03	< .001
Random Effects				
	Variance	df	Chi-Square	p
Between-teacher variability (Intercept) $\tau$	.898	3	9.15	.027
Student Level Variables				
Re-Taking Class $\gamma_{10}$	1.919	3	10.69	.013
Participation in Summer School $\gamma_{20}$	13.180	3	19.42	<.001
Within-teacher variability $\sigma^2$	1.638			

The above model demonstrates there is a fixed effect for a student being identified as African American with a coefficient of -1.067. This means, on average, a 1.067 point

decrease could be expected in ACT mathematics score attributable to a student being African American. Additionally, re-taking the class and participation in Plato were found to be statistically significant as random effects, though not as fixed effects. This means while there was no average treatment effect for participation in either of these credit recovery options, their effects do vary across teachers the students had for the failed course. This means some teachers were more effective than others in preparing their students for both of these remediation options in terms of improving ACT mathematics scores. These findings will be further explored, along with those concerning the Algebra I data analysis, in the discussion section of this study.

## CHAPTER V: DISCUSSION

This study explored what happened in one school's credit recovery program in terms of student outcomes. It addressed a first research questions concerning which credit recovery option was most closely associated with student attainment of college- and career-readiness benchmarks and also a second research question concerning how student characteristics explained variability in ACT scores. Taken into account were factors commonly used in educational research, including race, gender, and socioeconomic status. Additionally, the study considered that students who failed only one semester of Algebra I or Geometry might have had different outcomes than students who failed both semesters, and PLAN mathematics scores were used as a measure of previous achievement. The study's data hierarchy structure took into account students who have the same teacher for a failed course are more alike than students who had different teachers.

This chapter further discusses the findings from Chapter IV for both the Algebra I and Geometry data analyses, along with including implications that follow from the results of this study for those interested in credit recovery program including administrators, counselors, and teachers. Also included are limitations of the study and suggestions for future research that might help to complete this picture of how best to move these students towards being successful.

### **Results from the Algebra I Model**

From the null model for the Algebra I data analysis, it was found the average ACT score for these students was 16.08. This is, of course, of interest because this study examined these student results in terms of reaching college- and career-readiness

benchmarks. The null model showed this group of students, on average, did not reach the desired score of 19 indicating readiness for introductory college mathematics courses by the time they took the ACT in the spring of their junior year. The variance at the teacher level was not found to be statistically significant, meaning not much variation in these students' ACT scores could be attributed to teachers. Similarly, Intraclass Correlation was calculated to be .020, meaning only 2% of variance in ACT scores could be attributed to the teachers of the failed course, leaving 98% attributable to individual students. Reliability was also found to be low, indicating teachers could not be "easily" separated according to these scores. Together these results suggest the outcomes of these teachers are similar to each other in terms of how these students later score on the mathematics portion of the ACT, so as schools look for ways to help students who have failed a course such as Algebra I or Geometry, continuing to look at factors beyond what teachers are doing would likely be useful.

Since so much of the variation, 98%, was attributable to individual students, it was especially important the second research question for this study addressed how student level variables affect ACT scores, and the combined model sheds light on what played a particularly important role. First, the combined model found a grand mean of 15.67 when adjusted for student variables including race, gender, socioeconomic status, previous achievement, and type of credit recovery option participated in. This mean is more realistic since it takes these variables into account, and it should again be noted it is far below the benchmark score of 19.

The combined model showed that none of the credit recovery options were found to be statistically significant as fixed effects. This means, on average, none of the

Algebra I remediation programs impacted ACT mathematics scores. So addressing the first research question more specifically, there was no credit recovery option for Algebra I shown to be more closely associated with helping students reach the college- and career-readiness benchmarks than any of the other programs.

Addressing the second research question concerning student characteristics such as gender, race, socioeconomic status, and PLAN mathematics scores, the analysis revealed that none were statistically significant as fixed effects. This means, on average, these variables also had no impact on how these students performed on the mathematics portion of the ACT. For gender, this seems in line with previous research which shows that there is not as much gender difference in mathematical achievement as once thought. For socioeconomic status, the result is more surprising, since the literature is more consistent in showing that students of low socioeconomic status are at a disadvantage. Previous research also indicates that African American students underachieve in comparison to their White peers, and for the Algebra I analysis, this was not shown to be the case, with race having no average impact on ACT mathematics scores.

While there were no statistically significant fixed effects, several variables were found to be statistically significant as random effects, meaning their impact depended on the teacher the student had for the failed semester(s) of Algebra I. One of these variables was participation in re-taking the class to make up Algebra I credit. So while there was, on average, no effect on ACT scores resulting from re-taking the class, the effects did vary across the teachers the students had for the failed course. This means some teachers were better than others at preparing students to reap the benefits of re-taking the class. The PLAN mathematics score was also statistically significant as a random effect.

Similar to re-taking Algebra I, PLAN mathematics scores did not have an average effect on ACT mathematics scores, and this finding is likely to be surprising to educators, who often use sophomore year PLAN scores to gauge which students need additional preparation before taking the ACT junior year. This study, however, did not indicate this, instead finding PLAN mathematics scores test were not, in general, a good predictor of ACT mathematics scores. The results instead showed that PLAN mathematics score was statistically significant as a random effect. This means some of the teachers the students had for their failed semester(s) of Algebra I were more effective than others in helping prepare students to score better on the ACT based on increases in PLAN scores.

The final characteristic found to be statistically significant as a random effect was student identification as being White. There were no measureable fixed differences between students that were White, African American, and Hispanic, meaning racial-ethnic differences could not be used to predict ACT scores. Most educators would view this as a positive result since, as discussed in the Literature Review, minorities have often in the past experienced lower academic achievement. However, identification as White was statistically significant as a random effect. Just like for student participation in re-taking the class and PLAN mathematics scores, this means while there were no average effect of being White, teachers varied in the effectiveness in helping these students prepare for the ACT. Of course, for all of the statistically significant random effects, the question follows what teacher characteristics cause these results to vary. However, it is a limitation of this study that no data concerning teacher characteristics was collected, and thus this study did not explore what might cause these differences in teacher effects.

A final outcome of interest can be found in the data analysis for Algebra I. Re-taking the class, identification as White, and PLAN mathematics scores were all found to be statistically significant as random variables, but the slope for re-taking the class had much more variance than the other two, meaning the effects of re-taking the class varies much more strongly across the different teachers than the effects of PLAN mathematics scores and identification as being White. Perhaps, then, this is the characteristic researchers might look further into first, as the difference between teachers who prepared these students well for this option and those who did not were more extreme than the other effects. This means this is a place where we could learn, in particular, what is helpful to these students and what is not. Additional implications and calls for future research can be found later in this chapter, after a discussion of the results from the Geometry data analysis.

### **Results from the Geometry Model**

In the data analysis for Geometry, a null model was run, and the mean ACT mathematics score was found to be 15.84. This is again well below the desired benchmark score of 19, demonstrating this group of students is at risk for not reaching college- and career-readiness. Similar to the data analysis for Algebra I, the null model for Geometry also showed the teachers the students had for the failed courses were not responsible for much of the variance in ACT score. Variance at the teacher level was not found to be statistically significant, and the Intraclass Correlation was found only to be .0003, meaning only .03% of the variance in ACT mathematics scores was attributable to the teachers, leaving 99.97% attributable to the individual students. Additionally,



reliability was also low for this model, meaning again, teachers were not easily separated according to the student ACT scores.

The full model for the Geometry data identified student characteristics responsible for the variation in ACT scores, along with providing a grand mean adjusted for the student level variables. For the Algebra I data analysis, this adjusted mean was lower than the mean found in the null model (15.64 versus 16.08 respectively). For the Geometry data, however, the adjusted mean was actually higher than the mean of 15.84 mentioned previously, at 16.63.

Determined in the full model were the variables found to be statistically significant in predicting student ACT mathematics scores. Unlike the data for Algebra I, in which no variable was found to be statistically significant as a fixed effect, identification as African American was found to have an average negative impact on ACT scores. While this is unsurprising considering the results found in the literature concerning racial-ethnic differences in academic achievement, it is curious this result was found for the Geometry data analysis but not for Algebra I, and this is another call to researchers to examine why these differences continue to persist. All other variables, however, were not found to be statistically significant as fixed effects. This means that in answer to the first research question, no credit recovery option for Geometry was particularly associated with student attainment of college- and career-readiness benchmarks. Concerning the second research question, race was found to play a role, though gender and socioeconomic status did not have an average impact.

The two variables found to be statistically significant as random effects were re-taking the class and participation in summer school. Re-taking the class was also found

to be statistically significant as a random effect in the Algebra I data analysis, and the interpretation is much the same. While, on average, there is no impact on ACT mathematics scores attributable to re-taking the failed semester(s) of Geometry in the traditional classroom setting, the impact of taking the class varies across which teacher the student had originally. Enrollment in summer school was also found to be statistically significant as a random effect in the Geometry data analysis. Similar to the results for re-taking the class, enrollment in summer school had no average effect on ACT scores, but the impact of making up credit in summer school varied across which teacher the student had in class, again implying some teachers are better than others at preparing students for this option. It should also be noted the variance for enrollment in summer school was quite a bit higher than the variance for the other random variable, re-taking the course. This means there was a bigger difference in how the outcomes varied across teachers for summer school, and perhaps provides the biggest opportunity for researchers to learn what can help prepare students for this option. The next section of this chapter further discusses what can be taken away from the results of this study and suggestions for future research.

### **Implications and Suggestions for Further Research**

The implications of both the Algebra I and Geometry data analyses are presented here together. First was the surprisingly small number of variables statistically significant as fixed effects. Only the identification as African American had a fixed impact on scores, and only for the Geometry analysis. Amongst both of the groups of students, no other variable, including gender, socioeconomic status, previous achievement measures, or participation in any of the credit recovery options were found

to have an average impact on student achievement. The original goal of this study was to identify if any of the credit recovery options, did, in fact, make a bigger positive impact on student ACT scores than the other options. On one hand, this study showed none of the credit recovery options seemed to have had a consistent impact on ACT scores, either good or bad. However, there are many other possible benefits and drawbacks to credit recovery program not within the scope of this study.

One possible advantage of a credit recovery option over another might be student retention (how many students actually finish the credit recovery option once they start). Another possibility is more abstract, but is likely to be an important factor for these students in particular, and it is that some credit recovery options might help students avoid becoming disillusioned with school. These are all students who have failed at least one semester of an important mathematics course early in their high school career which is, as discussed in the literature review, a particularly critical time in their academic life. Also discussed was the idea these students can be thought of as struggling learners. Two of the characteristics typical of these students are learned helplessness and mathematical anxiety, brought about by what could be a long-standing pattern of failure or low performance in the classroom. It could be easy for these students to become discouraged, but perhaps if a credit recovery option helped, in particular, to build student confidence, it might have benefits that go beyond test scores such as encouraging students to stay in school and strive to make the most of their educational opportunities. Another possibility might be that some credit recovery options, especially those that allow students to make up their credit in a shortened amount of time, might encourage students about school in general by allowing them to continue to make forward progress towards graduation,

which would be especially important if they have also failed courses in other important subject areas.

Additional implications of this study might be found by noting the large amount of deletions that had to be made from the original data sets. Some reasons for deletion are most likely not a direct result of the happenings within the school, including students moving out of district. Other reasons, such as school drop-out, are quite complex. While the school may play a role, an examination for the causes of drop-out was outside the scope of this study. However, some students had to be deleted because they had not made up their course credit before taking the junior year administration of the ACT, and this is, for the most part, largely in control of the school. While no student can be forced to participate in programs such as summer school or Plato, the school can vary in its expectations for the timeliness of making up failed credits. One potential way this might be done is to insist students make up their credit before they move to the next class. Perhaps if students knew they would be required to repeat a class like Algebra I their sophomore year instead of moving on to Geometry with their peers, they might be more motivated to attend summer school or seek out a way to complete Plato at home. This insistence would also have a likely outcome of increased success in subsequent classes, since students would not be able to move on until prerequisite skills were obtained. In order to make this a reality, schools must be careful in the structuring of summer school opportunities, doing things like scheduling summer classes for mathematics at a different time than those offered for subjects such as English, so students would not have to choose between the two. This would be especially true for students who fail Geometry since they have less time between the failed class and the junior year administration of the

ACT. The data seemed to confirm that this was indeed the case, since for Algebra I,  $n = 20$  students (4% of the total data sample) took the ACT before making up their credit, and for Geometry,  $n = 68$  students took the exam before making up the class (accounting for 15% of the total sample). This means that for administrators and school counselors, it is especially important to provide ample opportunity shortly after sophomore year for students who have failed Geometry to make up their credit before they are juniors, giving students the best chance possible at obtaining the college- and career-readiness benchmark on their first attempt.

Overall, this study looked at student characteristics, credit recovery options, and categorized students by teachers, examining what affected college- and career-readiness as measured by ACT mathematics scores. However, the process of reaching college- and career-readiness is quite complicated and there are many other factors that should be taken into account in future research to gain a broader picture of the process. For example, this study looked at both Algebra I and Geometry course failure, and there are other factors that differentiate how credit recovery for these two courses might be different. One example of this is when students usually take these classes, with Algebra I being earlier, allowing more time for the class to be made up before the ACT. Another difference is that Geometry is, in a way, a stand-alone course. While Algebra II teachers, knowing their students will be taking the ACT in the spring, might review some Geometry topics, there is not a lot of overlap between the two curricula. Algebra I skills, however, are inherently embedded in Algebra II content. Thus Algebra II teachers, especially those who have students in their class at risk for lower achievement, will almost surely review Algebra I concepts to help increase the chance of student success in

learning new topics. Therefore, the process for learning Algebra I material missed during the first time the students took the class may not just happen during the credit recovery program, but after as well. For Geometry, on the other hand, the credit recovery program might be these students' last real opportunity.

Additionally, this study used data from students who had failed either Algebra I and/or Geometry. There were no distinctions drawn based on what type of failing grade the student received. Some students might be quite close to passing a class, while others might fail a course with an extremely low grade. There is a possibility that academic outcomes on assessments such as the ACT, and the effectiveness of credit recovery options, might differ based on how severely a student failed a course. Future research might examine these differences and be able to make further recommendations concerning how best to help students based on the "type" of failing grade they earned.

### **Limitations**

As with most studies concerning education, there are definite limitations to this study. For one, due to the inconsistency in tracking student records, data from only one high school was available, limiting the generalizability of the results. Hopefully in the future, school districts looking to examine results of programs such as credit recovery will encourage counseling offices to have more consistent methods of recording how students make up classes so that results can be compared. Also, the number of deletions that had to be made considerably reduced the usable sample size. This would yet again reduce generalizability, and might have affected the results of the analysis because of a lessened chance of finding statistical significance for the predictors. Another previously mentioned limitation of this study is the lack of teacher-level data. While the results

showed different teachers provide different results, this study does not allow for investigation into what types of teacher characteristics contribute to these outcomes.

## **Conclusion**

While this study had some limitations, it contributed to the body of research knowledge concerning college- and career-readiness and how setbacks, such as course failure, can affect student ability to move forward towards postsecondary education and vocational training. From the results, we can see some variables such as gender and socioeconomic status do not always play much of a role. Additionally, the study allowed for exploration into how other factors like race can play a role and not always in ways typically found in the literature. It also demonstrated the options schools provide to students for credit recovery may not always have a clear “winner” in terms of raising ACT mathematics scores, but we can start to explore how the teachers the students had for the original course can help make these more or less effective. The take-away from the study is perhaps that while the road to college- and career-readiness is certainly a complicated one, credit recovery options are one piece of the puzzle that can be further explored, helping students move from failure to success.

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